DOCUMENT RESUME

ED 347 089 SE 052 938

AUTHOR	Robitaille, David F., Ed.
TITLE	T.le 1990 British Columbia Mathematics Assessment: Technical Report.
INSTITUTION	British Columbia Dept. of Education, Victoria.
REPORT NO	ISBN-0-7726-1435-0
PUB DATE	90
NOTE	443p.
PUB TYPE	~ .lected Works - General (020) -- Reports - Evaluative/Feasibil'ty (142)
EDRS PRICE	MF01/PC18 Plus Postage.
DESCRIPTORS	Algebra; Attitude Measures; Cognitive Measurement; Foreign Countries; Geometry; Grade 4; Grade 7; Grade 10; High Schools; Intermediate Grades; Junior High Schools; *Mathematics Achievement; Mathematics Education; Mathematics Instruction; Mathematics Skills; *Mathematics Teachers; Number Concepts; Problem Solving; Questionnaires; School Surveys; *Student Attitudes; *Teacher Attitudes; Teacher Background
IDENTIFIERS	*British Columbia; Canada

ABSTRACT

This book presents the results of the fourth British Columbia Mathematics Assessment conducted in the spring of 1990. Students in Grades 4, 7, and 10 (approximately 120,000) were asked to provide information about themselves, to express their opinions about school-related experiences, and to demonstrate their ability to do the mathematics prescribed in the recently revised provincial mathematics curriculum. Mathematics teachers (approximately 4,500) were asked to provide information about their personal and professional backgrounds, about the kinds of teaching practices they employed, and about the extent to which they followed the curriculum. The book is organized into eight chapters written by six curriculum and mathematics specialists. Chapter 1 (David Robitaille) provides the scope and organization of the assessment. Chapter 2 (Alan Taylor and David Robitaille) describes the process used to develop the instrumentation used to collect information from the students and teachers and how the results were interpreted. Chapter 3 (Valerie Overgaard and David Robitaille) describes results from the teacher questionnaires, and chapters 4, 5, and 6 (by Thomas Schroeder, Leslie Dukowski, and Alan Taylor respectively) report the achievement results from identified curriculum strands and problem solving, and students' attitudes and opinions for grades 4, 7, and 10. Chapter 7 (Walter Szetela) reports results on problem-solving performance, providing cross-grade comparisons, results by gender, and attitudes toward problem solving. A concluding chapter by David Robitaille identifies and discusses four areas of concern that need improvement: (1) participation of women; (2) implementation of the curriculum; (3) teaching methods; (4) student outcomes. Appendices include a lists of contributors to the report, committees, review panels, tables of results, student achievement items for grades 4, 7, and 10, student background questionnaires, and teachers' questionnaires. (MDH)

The 1990 British Columbia Mathematics Assessment

Technical Report 1990

The 1990 British Columbia Mathematics Assessment

Technical Report

edited by

David F. Robitaille
University of British Columbia

Members of the 1990 Mathematics Assessment Contract Team

David F. Robitaille	Faculty of Education University of British Columbia
Gillian Clouthier	Vice-Principal North Vancouver School District
Leslie H. Dukowski	Principal Langley School District
William Kokoskin	Department Head North Vancouver School District
Kanwal Neel	Mathematics Teacher Richmond School District
Valerie J. Overgaard	Faculty of Education University of British Columbia
Thomas L. Schroeder	Faculty of Education University of British Columbia
Darlene Shandola	Consultant Richmond School District
Alan R. Taylor	Director of Instruction Coquitlam School Disrict

Canadian Cataloguing in Publication Data
Main entry under title:
The 1990 British Columbia mathematics assessment:
technical report

ISBN 0-7726-1435-0

1. Mathematics - Study and teaching - British Columbia. 2. Mathematical ability - Testing. 3. Curriculum evaluation. I. Robitaille, David F. II. British Columbia. Mathematics Assessment Contract Team. III. British Columbia. Ministry of Education and Ministry Responsible for Multiculturalism and Human Rights. Assessment, Examinations and Reporting.

QA14.C32B75 1991 510.7'10711 C91-092332-9

PREFACE

This report of the 1990 British Columbia Mathematics Assessment contains a description of each of the major components of the study, an analysis of the major findings, and several suggestions for improvement directed at policy makers in the educational system of the province. The goals of the assessment were to monitor patterns of students' achievement in and attitudes toward mathematics, to trace changes in that achievement since the 1985 assessment, to obtain information about the degree to which the revised curriculum has been implemented, and to conduct a survey of instructional practices employed by teachers of mathematics.

In the 1985 project, a special set of booklets consisting of open-ended items was used with a sample of students to investigate students' problem-solving strategies. Results of that study were very encouraging, and a similar approach was used in the 1990 study. Those results are discussed in Chapter 7 of this report.

The members of the Contract Team who carried out this assessment on behalf of the Ministry of Education are grateful to all of the teachers, department heads, principals, and school district personnel throughout the province for their cooperation. In addition, special thanks are due to Sandra Crespo, Thomas García, Mike Marshall, and the staff of the Education Measurement Research Group at U.B.C. whose assistance in the analysis of the data from the assessment and in the preparation of this report was invaluable.

David F. Robitaille

Department of Mathematics
and Science Education

University of British Columbia

TABLE OF CONTENTS

Chapter 1

Introduction

David F. Robitaille

The fourth British Columbia Mathematics Assessment was conducted in the spring of 1990. During the week of May 14-18, about one month before the end of the school year, all students in Grades 4, 7, and 10 throughout the province were asked to provide information about themselves, to express their opinions about a variety of matters related to their school experience, and to demonstrate their ability to do the mathematics prescribed for them in the recently revised provincial mathematics curriculum. Many teachers of mathematics also participated in the assessment by responding to questionnaires developed for use i the study. They were asked to provide information about their personal and professional backgrounds, about the kinds of teaching practices they employed in their day-to-day teaching of mathematics, and about the extent to which they were teaching the topics prescribed in the curriculum guide (Ministry of Education, 1987, 1988).

Previous mathematics assessments were conducted in 1977, 1981, and 1985 (Robitaille & Sherrill, 1977; Robitaille, 1981; Robitaille & O'Shea, 1985). The 1977 and 1981 evaluations involved students in Grades 4, 8, and 12, although a sample of Grade 10 students did participate in the 1981 study. For the 1985 assessment, it was decided that Grades 7 and 10 were more appropriate grade levels at which to assess students' performance, and so these grades replaced Grades 8 and 12. Grade 7 is the last year of elementary school, and is therefore an important crossroads in the academic careers of students. Grade 10 is the last year of compulsory schooling for most students, as most of them attain the age of 16 at some point during that school year.

Organization of the Assessment

As with any other large-scale evaluation project, several groups of people, representing virtually all of the major stakeholders in mathematics education in the province, participated in planning and carrying out the 1990 Mathematics Assessment. These included the members of the Contract Team which had the overall responsibility for carrying out the assessment, the staff of the Assessment, Examinations, and Reporting Branch of the Ministry of Education, the members of the Advisory Committee, the Review Panels, the Marking Panels, and the Interpretation Panels. Approximately 120 000 students participated in the study by completing the assessment booklets and about 4500 teachers completed the teacher questionnaires.

The Contract Team was responsible for designing the assessment, developing the instruments to be used in the project, and writing the final reports. The team included two members of the Department of Mathematics and Science Education at the University of British Columbia, a school principal from Langley School District, the Director of Instruction from the Coquitlam School District, and a curriculum consultant from the Vancouver School Board. They were assisted by a principal from the New Westminster school district; a teacher, a vice-principal, and a consultant from Richmond; and a department head from North Vancouver. The names of the members of the Contract Team and of each of the other major committees set up for the 1990 assessment are listed in Appendices A and B.

The Advisory Committee provided guidance and advice to the Contract Team and the Assessment, Examinations, and Reporting Branch on the development of the instruments and a variety of other matters concerning the study. They were selected from across the province by the Assessment, Examinations, and Reporting Branch to represent a cross-section of opinion on matters related to the teaching and learning of mathematics. The committee included among its members teachers, school- and district-level administrators, two university professors. The Chairperson of the Contract Team and two members of the Assessment, Examinations, and Reporting Branch served as *ex officio* members of the Advisory Committee.

The Review Panels and the Interpretation Panels were made up of educators and informed members of the public selected to represent various areas of the province and all levels of education in the K-12 system. The task of the Review Panels was to discuss the objectives of the assessment, and to comment on the test items, attitude scales, and questionnaires developed for use in the project. The mandate of the Interpretation Panels was to consider the results of the assessment and to make decisions about students' performance on the tasks given to them.

Scope of the Assessment

Systematic collection of reliable data about schools and the knowledge, skills, and attitudes of the students is an essential component of the responsible management of education in the province. So too is the dissemination of the findings arrived at through the analysis of that data. Decisions about new directions or new emphases in the educational system should be based on a thorough understanding of what students have learned and how they are being taught. The purpose of the Provincial Learning Assessment Program in British Columbia is precisely that: to collect information about what students are being taught and what they are learning, and to make that information available to everyone who has an interest in the outcomes of education in this province. This includes not only parents and teachers, but also taxpayers, employers, educators at all levels, policy makers, administrators, researchers, and elected officials.

The general goals of the Provincial Learning Assessment Program are:

- to inform professionals and the public at large about the strengths and weaknesses of the school system;
- to assist the Ministry of Education, school districts, and schools in making decisions related to the development, review, modification, revision, and implementation of curricula and supporting instructional resource materials;
- to provide the Ministry of Education with the information required to assist them in reaching decisions about the allocation of resources to school districts;
- to identify areas of need, and provide directions for change in preservice and in-service teacher education and professional development;

- to provide directions for educational research;
- to monitor student learning over time; and,
- to provide the province, school districts, and schools with information which they can use to identify areas of strength in the educational system as well as areas where improvement is desired.

Within the framework of these general guidelines, the 1990 Mathematics Assessment was designed to address the following major questions:

- To what extent are students in Grades 4, 7, and 10, in both the public and independent school systems of the province, achieving the objectives of the prescribed mathematics curriculum?
- What mathematical concepts, skills, and techniques have students at each of the grade levels mastered? That is to say, what mathematics can these students do?
- To what extent have levels of achievement changed from those described in reports of the mathematics assessments conducted in 1977, 1981, and 1985?
- To what extent are topics such as data analysis and transformational geometry, which are either new to the curriculum or have been accorded increased prominence in the new curriculum, being taught in the classrooms of the province?
- What kinds of teaching practices do teachers of mathematics employ, and how have those teaching practices been affected by the introduction of the new curriculum?
- What are teachers' and students' opinions concerning how important selected curricular topics are, how easy those topics are to learn or to teach, how much they enjoy learning or teaching those topics, and to what extent do their opinions differ?

At each of the Grades 4 and 7 levels there is a single mathematics curriculum prescribed by the Ministry of Education, and it is expected that all teachers will follow that curriculum using one of the textbooks approved for that grade. For Grade 10, two courses have been prescribed: Mathematics 10 and Mathematics 10A. The latter course is intended to afford students who have been experiencing difficulty in mathematics an opportunity to master some of the underlying concepts and skills needed to succeed. The course is not intended as a terminal course; instead, it is hoped that students who take this course will be able to re-join the regular sequence of academic mathematics course, perhaps by taking Introductory Mathematics 11 during the subsequent semester or year.

The contents of the two Grade 10 mathematics courses are significantly different from one another, and it would have made little sense to ask all students

to respond to the same achievement items. On the other hand, there is some overlap between the two, so it was not necessary to develop two completely different sets of items. The Grade 10 booklets were therefore divided into three sections–X, Y, and Z–with 20 items in each, and each student responded to two of the three parts. Students who were enrolled in Mathematics 10 responded to Parts X and Z, while students in Mathematics 10A responded to Parts X and Y.

Participation Rates

All students enrolled in Grades 4, 7, and 10 in public or in Group 1, 2, and 4 independent schools were expected to participate in the assessment. Instructions to that effect were circulated to all schools and school districts in the province by the Assessment, Examinations, and Reporting Branch. Generally speaking, the only students who were to be excused from participation were those with moderate to severe mental handicaps, and this is estimated to include no more than two percent of the student population at any grade level.

The data on participation rates are summarized in Table 1-1. The Grade 4 assessment booklets were completed by almost 40 000 students; the Grade 7 booklets, by about 37 000; and the Grade 10, by about 31 000. The most recent information available from the Ministry of Education on the numbers of students enrolled in those three grades is based on data collected from school districts at the end of September 1989. The total enrollment figures in Table 1-1 must therefore be interpreted with caution, as there would have been considerable turnover of students within the system during the more than six months which elapsed from the time when the enrollment data were collected to the time when the assessment instruments were administered. In any event, the results indicate that participation rates were very high although the Grade 10 participation rate was considerably lower than that of the other two.

For the first time in a mathematics assessment in British Columbia, French versions of the instruments were made available for use in French immersion classes as well as in those following the *Programme-cadre de français*. Since mathematics is not always taught in French in immersion classes, schools were asked to use the language of instruction for mathematics as the determining factor in deciding whether to use the English or the French version of instruments.

Table 1-1. Participation in the 1990 British Columbia Mathematics Assessment.

	Grade 4	Grade 7	Grade 10
English Booklets	37574	35753	31257
French Booklets*	1935	1641	225
Total Booklets	39509	37394	31482
Total Enrollment†	38776	37214	37588

*Written by students who were taught mathematics in French
†Enrollment data as of 1989/09/30 supplied by the Ministry of Education

The data in the table show that the numbers of students in the province who are being taught mathematics in French – either in immersion classes or in *Programme cadre de français* – drops off very sharply as grade level increases. In Grade 4, about 5 percent of students responded to one of the French booklets. By Grade 7 this rate dropped to slightly more than 4 percent, and to less than 1

percent in Grade 10. Such low rates of participation raise questions about the economic advisability of having French-language versions of the assessment instruments prepared.

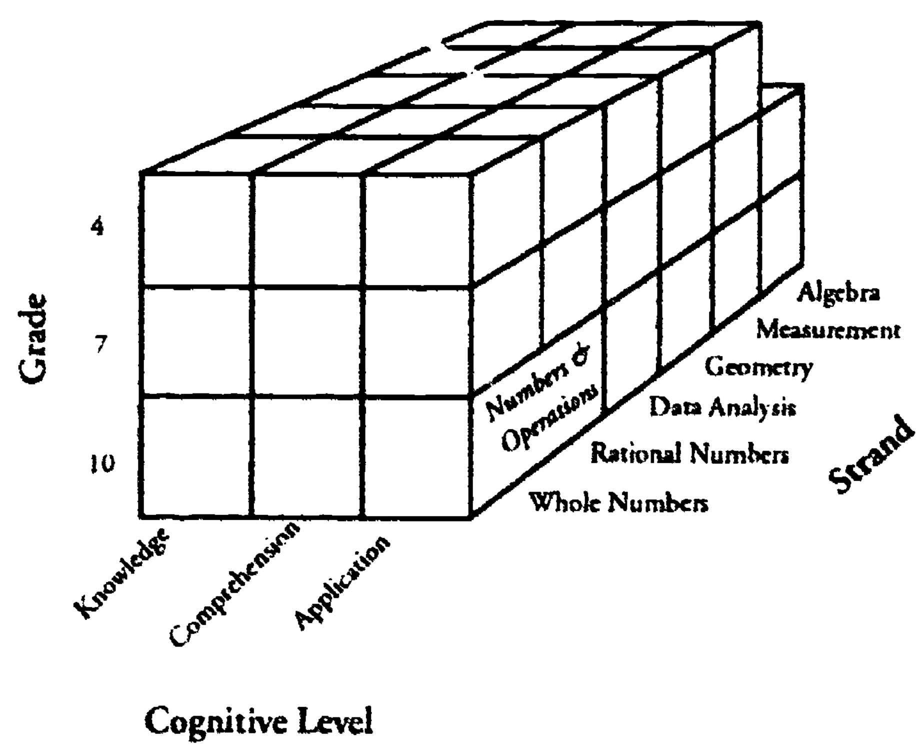
Achievement Measures

The primary objective of every provincial assessment is to obtain valid information about students' achievement in particular areas of the curriculum. The focus of attention in this report is the educational system as a whole, and the questions concern how well that system is performing rather than how each student or each school or each school district is performing.

For the achievement sampling component of the 1990 Mathematics Assessme t a two-way table of specifications was developed, with mathematical content along one dimension and cognitive behavior level along the other. The content dimension was partitioned into six *strands* for Grades 4 and 7 and five for Grade 10. Each *strand* was itself then partitioned into several *topics*. The cognitive behavior dimension was partitioned into three levels: knowledge, comprehension, and application/problem solving in much the same way as in previous mathematics assessments. This structure is summarized in Figure 1-1.

Large numbers of achievement items in multiple-choice format corresponding to the cells of the item specification model were assembled from a variety of sources. These included previous provincial assessments, and similar evaluation programs in other jurisdictions. Many other items were developed expressly

Figure 1-1. Item specification model for the 1990 mathematics assessment.



for use in this project, particularly for those strands and topics which had only recently been added to or received increased attention in the mathematics curriculum. All of the newly developed items were pilot tested in the Fall of 1989, and

revisions or corrections were made as needed on the basis of those results.

The multiple-choice items were distributed among four test booklets for each grade level and each student was expected to respond to 40 items during the hour allocated for the assessment. The booklets were balanced for difficulty as well as for content, and a timing pilot was carried out in a small number of classes to ensure that virtually every student would have sufficient time to respond to all of the items in his or her booklet.

Two booklets consisting of open-ended problem-solving items were also prepared for each grade level, and these were administered to a provincially representative sample of classes shortly after the regular assessment. These so-called *Q-forms* were also a feature of the 1985 assessment, and proved to be a valuable source of important information about students' achievement which could not have been collected otherwise. The multiple-choice format is not a good vehicle for assessing areas such as problem solving, where students need to be given an opportunity to work toward a solution.

All of the booklets included a number of items designed to obtain information about students' backgrounds, opinions, and attitudes. They were also asked about several aspects of their classroom experience with mathematics, and their use of calculators and computers.

Teacher Survey

All teachers of mathematics at each of Grades 4, 7, and 10 were asked to respond to comprehensive questionnaires developed for use in the study. The questionnaires were divided into five major sections dealing with aspects of the teachers' academic and professional backgrounds and experience, their opinions about a variety of topics included in the newly revised curriculum, their utilization of selected teaching practices, the degree of implementation of the new curriculum, and the availability of resources and professional development opportunities related to the new curriculum. Teachers were also asked to indicate, for each of 20 items from the achievement items administered to their students, whether or not the mathematical content needed to respond correctly to the item had been taught. This is referred to throughout this report as Opportunity to Learn, and is a concept borrowed from the Second International Mathematics Study (Robitaille and Garden, 1989).

Summary

The 1990 Mathematics Assessment, like its predecessors, was designed to produce a portrait of the state of the teaching and learning of mathematics in the schools of the province. The major areas of attention in this report concern students' achievement, their attitudes and opinions about a number of topics of contemporary interest in the fields, and the opinions and attitudes of the teachers of mathematics.

Chapter 2 of this report provides additional information of a technical

nature about the development of the assessment instruments, about their statistical characteristics, and about the distribution of items across forms. This is followed by a description of the results from the teacher questionnaires in Chapter 3. Results from the survey of students' performance and attitudes are contained in Chapters 4, and 5, 6. This is followed, in Chapter 7, by a synopsis of the results from the open-ended items or Q-forms. The report concludes with a summary and recapitulation of the major findings and conclusions from the assessment in Chapter 8.

References

Ministry of Education (1987). *Mathematics Grades 1-8. Curriculum Guide.* Victoria: Curriculum Development Branch.

Ministry of Education (1988). *Mathematics Grade 7-12.* Victoria: Program Development Division.

Robitaille, D. F. (Ed.) (1981). *The 1981 British Columbia Mathematics Assessment: General Report.* Victoria: Ministry of Education.

Robitaille, D.F. & Garden, R.A. (1989) *The IEA Study of Mathematics II: Context and Outcomes of School Mathematics.* Oxford: Pergamon Press.

Robitaille, D. F. & O'Shea, T. J. (Eds.) (1985). *The 1985 British Columbia Mathematics Assessment: General Report.* Victoria: Ministry of Education.

Robitaille, D. F. & Sherrill, J. M. (1977). *The British Columbia Mathematics Assessment. Test Results.* Victoria: Ministry of Education.

Chapter 2

Instrumentation and Sampling

Alan R. Taylor
David F. Robitaille

Information collected from students in the 1990 Mathematics Assessment included data from the following areas: achievement, background, attitudes toward mathematics, and perceptions of classroom practices. In addition, the following information was collected from teachers: background characteristics, implementation information, classroom practices, perceived status of topics in mathematics, and content taught. A description of the instruments used to collect information from teachers, the procedures used in their development, and a discussion of the results is included in Chapter 3.

Student-level information was collected on two types of forms, each of which contained different test item formats: multiple-choice and open-ended. All students responded to the multiple-choice items, and a random sample answered the open-ended ones.

This chapter describes the process used to develop the multiple-choice items and to organize them into booklets for the assessment. It includes an outline of the process undertaken in the development of multiple-choice items, as well as the content of the forms on which they were administered. The development of the open-ended items is discussed in Chapter 7.

The chapter begins with a description of the questions used to collect information on students' backgrounds, attitudes, and perceptions of classroom practices. Procedures used to develop achievement items and their placement on forms are discussed next. Finally, achievement categories and the process used for interpretation are reviewed.

Background Information

Students were asked to provide personal information about themselves which had been shown in earlier studies (Robitaille & O'Shea, 1985; Robitaille, 1981) to be related to differences in achievement. Questions in this area dealt with age, gender, and program. At the Grade 10 level, program information was extended to include the specific mathematics course enrolled in and the way it was organized in the school (semester or full year). Grade 10 students were also asked what factors influenced their selection of the mathematics course they were taking.

At the Grade 10 level students were asked questions about their future plans. These included which courses they planned to enroll in during Grades 11 and 12, and what plans they had after completion of secondary school.

Attitudes toward Mathematics

Previous studies have shown that students' attitudes toward mathematics are related to achievement (Aitken, 1976; Phillips, 1973; Taylor, 1988; and Taylor & Robitaille, 1987), and students' perceptions of mathematics are important outcomes of the program. To collect information in these areas, students were

asked about their attitudes toward the importance of mathematics in the everyday world and their perceptions of the status of a number of major topics in the mathematics curriculum.

Students responded to three questions related to mathematics and work. They were asked their opinion about the necessity of knowing mathematics in order to get a good job, whether most people used mathematics in their jobs, and if they would like a job where mathematics is needed. A five-point Likert-format scale was used for responses which ranged from "Strongly Agree" to "Strongly Disagree". The same questions were used at each of the three grade levels.

Information about students' perceptions of major topics in the mathematics curriculum was collected on scales used in the 1985 Provincial Mathematics Assessment (Robitaille & O'Shea, 1985). They had been adapted from a scale entitled *Mathematics in School*, originally developed by the International Association for the Evaluation of Educational Achievement (IEA) and used in the Second International Mathematics Study.

The Mathematics in School scale contained nine different items for each of the three grade levels, listing major topics in the mathematics curriculum. Students were asked to rate each topic on three dimensions: Importance, Difficulty and Enjoyment. They responded on a five-point Likert scale, with options ranging as follows: Importance, "not at all important" to "very important"; Difficulty, "very difficult" to "very easy"; and Enjoyment, "dislike a lot" to "like a lot." The topics included at each grade level are listed in Table 2-1.

Table 2-1
Topics for Mathematics in School.

Grade 4	Grade 7	Grade 10
Check Answers	Basic Facts	Equations & Expressions
Decimals	Data & Graphs	Data Analysis
Fractions	Geometry	Decimals, Fractions & %
Geometry	Decimals	Estimate Answers
Graphs	Fractions	Exponents
Measuring	Percent	Perimeter, Area & Vol.
Whole Nos.	Per., Area & Vol.	Geometry
Use Calculators	Solve Equations	Problem Solving
Use Objects	Use Calculators	Trigonometry

The content validity of the scales was judged appropriate by the Advisory Panel and the Review Panels for each grade level. Since only three topics appeared on each test form, results are reported only at the item level, and estimates of internal consistency were not computed.

Classroom Practices

Students were also asked to think of their mathematics classes during a typical school week and to estimate the frequency with which certain activities

took place. The options from which they chose were as follows: Almost every period, Often, Sometimes, Rarely, and Never. The same nine activities were responded to by students at each grade level. A list follows:

- We go over our homework and discuss solutions.
- The teacher works with individual students.
- We use concrete materials (dice, coins, manipulative materials, etc.).
- We use computers.
- We use calculators.
- We have quizzes or tests.
- We work in small groups.
- The teacher lectures and we take notes from the blackboard or overhead projector.
- We work individually from our textbooks or on other exercises which the teacher assigns.

These items were spread across forms so that only three appeared in any one booklet. For that reason, results are reported only at the item level.

Achievement Items

The content to be assessed was divided into a number of strands and each strand into several topics. The strands were selected by the Contract Team from those identified in the *Mathematics Curriculum Guides Grades 1-8 and 7-12* (Ministry of Education, 1987, 1988). Where possible, strands and topics were standardized across grade levels. As is shown in Table 2-2, the weighting attributed to each strand reflected the importance given to that strand in the curriculum.

Table 2-2
Weighting of strands in percent.

	Grade 4	Grade 7	Math 10	Math 10A
Whole Numbers	47	12	15	33
Rational Numbers	20	34		
Data Analysis	8	12	15	17
Geometry	13	18	30	20
Measurement	12	12	10	15
Algebra	–	12	30	15

Note: For Grade 10, the Whole Numbers and Rational Numbers strands were collapsed into the Number & Operations Strand.

The Number and Operations strand was divided into two parts (Whole Numbers and Rational Numbers) for Grades 4 and 7 because of the importance of that strand at those grade levels. Since problem solving crosses over strands and topics, it is not shown as a separate strand. Instead, it was included as one of the behavior levels in the cognitive level dimension of the item specification model which was displayed in Chapter 1.

Generation and Selection of Items

In addition to new items developed specifically for use in this assessment, a number of others which had been used previously and whose psychometric properties were already known, were drawn from different sources. Among these sources were the following: the 1985 Provincial Mathematics Assessment (Robitaille & O'Shea, 1985), the National Assessment of Educational Progress in the United States, and the Second International Study of Mathematics.

Since items included in the pools reflected the topic weightings and cognitive behavior levels defined in the table of specification, they were intended to measure a wide range of outcomes in the curriculum and reflected various difficulty levels. Some items were also intended to provide comparisons between student achievement on the 1985 and 1990 Provincial Assessments of Mathematics.

All items were reviewed by the Advisory Committee prior to presentation to Review Panels. Following input from these sources, the Contract Team arranged items on pilot instruments for the next stage of development.

Pilot Testing

All items in the pool were pilot tested in order to determine their pyschometric properties. Items to be piloted at each of the Grade 4 and 7 levels were distributed across six pilot test forms. At the Grade 10 level eight forms were used: four each for Mathematics 10 and Mathematics 10A students.

Piloting was undertaken in 23 districts around the province in October, 1989. The sample involved students in Grades 5 and 8 for the Grade 4 and 7 items, respectively. Students in Math 11 wrote items intended for Math 10 students, whereas those in Introductory Math 11 and Math 11A wrote items intended for students in Math 10A. Items to be administered in French were written by students in French immersion classes at the corresponding grades. The numbers of classes participating at each level was as follows: Grade 5, 46; Grade 8, 42; and Grade 11, 43. Among these were 12 French immersion classes (7 at Grade 5, 2 at Grade 8, and 3 at Grade 11) who responded to French versions of the items. The 43 Grade 11 classes consisted of the following: 24 of Math 11, 9 of Introductory Math 11, and 10 of Math 11A.

Results from the pilot testing provided standard item statistics for each option. On the basis of these data, items with the following characteristics were either modified or dropped from consideration for inclusion in the final forms for the assessment:

- More than 95 or less than 10 percent of students answered the item correctly
- Not all distractors attracted respondents.
- The point-biserial correlation between the correct answer and total test score was less than 0.20.
- The biserial correlation between the correct answer and total test score was less than the corresponding correlation between a distractor and the total test score.

Final Test Forms

The Contract Team assigned items to final forms based on the topic and cognitive-behavior level weightings outlined in the table of specification. Four forms each containing 40 achievement items were assembled for Grades 4 and 7. At the Grade 10 level four forms were also used. However, the achievement items at this grade level were divided into three parts, each consisting of twenty items. All Grade 10 students answered Part X. Those in Math 10A also answered Part Y; while students in Math 10 responded to Part Z.

The assessment booklets were administered randomly within each classroom. At the Grade 4 level the numbers of students responding to each booklet ranged from 9012 to 9398, while the numbers ranged from 8533 to 8816 at Grade 7. Grade 10 students were divided into two groups: Math 10 and Math 10A. The numbers of booklets written at this grade were 21,894 for Math 10 and 7783 for Math 10A. Similar proportions of each of the four booklets were written by students in each of these courses.

An attempt was made to make the forms parallel by content weighting, cognitive behavior level, and difficulty at each grade. In addition, change items were distributed evenly across the booklets. Results, showing measures of the psychometric properties of each form, are summarized in Tables 2-3 through 2-6 which are presented on the next page.

The information in the four tables shows that the psychometric properties of the forms were similar at each grade or course level. For example, the range of variances across forms, in raw score means out of 40, were as follows: Grade 4, 0.5; Grade 7, 1.2; Math 10, 1.3; and Math 10A, 1.4. In addition, the standard deviations across forms at each level showed that students' scores were distributed about the means in similar ways.

Reliability coefficients ranged from 0.84 to 0.87 across forms for Grades 4 and 7, and for Math 10. These measures indicate that these forms were consistent and stable as measurement devices. Although the magnitudes of the reliability coefficients were lower for Math 10A, they were within the acceptable range. One possible reason for the lower magnitudes on these forms could be related to lower mean scores, where guessing may have had a greater effect on results.

The standard deviations and reliability coefficients were used to generate corresponding values for standard errors of measure. Table 2.3 shows the following ranges for this measure at each grade or course level: Grade 4, 2.75-2.83; Grade 7, 2.76-2.79; Math 10, 2.72-2.81; and Math 10A, 2.66-2.75.

Based on these results, it is reasonable to conclude that the forms at each level were parallel in content and structure. In addition, the values of these measures suggest that each form had a high level of accuracy and thereby provided a relatively stable measure of student achievement.

Table 2-3
Statistical properties of the assessment booklets: Grade 4.

	Mean	Standard Deviation	Reliability (KR 20)	Standard Error
Form A	20.2	7.1	0.85	2.75
Form B	20.6	7.6	0.86	2.79
Form C	20.1	7.4	0.87	2.80
Form D	20.6	7.1	0.84	2.83

Table 2-4
Statistical properties of the assessment booklets: Grade 7.

	Mean	Standard Deviation	Reliability (KR 20)	Standard Error
Form A	21.7	7.1	0.85	2.77
Form B	20.5	7.2	0.85	2.79
Form C	21.6	7.8	0.87	2.78
Form D	21.3	7.5	0.86	2.76

Table 2-5
Statistical properties of the assessment booklets: Mathematics 10.

	Mean	Standard Deviation	Reliability (KR 20)	Standard Error
Form A	21.6	7.8	0.87	2.75
Form B	20.5	7.9	0.87	2.81
Form C	21.6	7.5	0.87	2.74
Form D	20.3	7.6	0.87	2.72

Table 2-6
Statistical properties of the assessment booklets: Mathematics 10A.

	Mean	Standard Deviation	Reliability (KR 20)	Standard Error
Form A	13.7	5.6	0.76	2.72
Form B	13.4	5.9	0.79	2.70
Form C	14.8	5.8	0.78	2.75
Form D	14.5	5.9	0.80	2.66

Interpretation of Results

Achievement results were examined by Interpretation Panels brought together in Richmond during July, 1990. They interpreted results in two ways: first to determine expected levels of achievement, and second to describe what knowledge and skills students were able to demonstrate.

For the first task, panel members determined expected and desired levels of student performance on each achievement item in the assessment. This was done initially as individuals, and subsequently as a group. Using this approach the panels arrived at consensus on the extent to which the actual performance of students varied from their expectations.

The intent of the second task was to describe the mathematics which students at each of four levels of performance could do. These performance levels were labelled as Categories 1 to 4, going from the most basic to the most complex respectively. A description of the process follows.

Items were first divided into the four categories using Item Response Theory to gain estimates of difficulty. Steps in this process were as follows:

1. Three-parameter estimates for each item were generated by form.

2. Using the estimates, a calibrated value was determined for each item with an estimated probability that a student would answer it correctly set at 0.70.

3. The items from all forms at each grade/course level were ordered according to their calibrated values.

4. Four categories of items were clustered at each grade/course level using the mean calibrated value and one standard deviation on either side of it as the cut scores.

Once the items were grouped in this way, the Interpretation Panel examined the outcomes which were measured by items contained in each category. The knowledge and skills needed to respond correctly to the questions were then described. Since the category levels were hierarchical, the knowledge and skills associated with one level were extended further at a subsequent one. Using this information the Interpretation Panels characterized student abilities as evidenced by the behaviors needed to respond to them correctly.

This technique added a second dimension to the interpretation of results. For example, not only did the panels identify discrepancies between expectations and actual performance levels, but they also described what students associated with each of four categories of achievement could do. It was only the second time in a provincial assessment that achievement levels were defined in this manner and a number of technical issues which were addressed will likely be refined in subsequent studies.

Further analysis of the results provided an estimate of the proportion of students who, seven times out of ten, would answer at least one item correctly at each level. The estimated proportion of students at each grade level associated in this way with the knowledge and skills attributed to each achievement category are shown in Table 2-7.

Table 2-7
Percent of students in each achievement category.

Category	Grade 4	Grade 7	Math 10	Math 10A
1	95	98	96	78
2	59	66	61	19
3	21	40	27	4
4	3	5	9	0

The proportion of students associated with each category, by grade or course, is a subset of those in preceding categories. For example, 95 percent of all students at the Grade 4 level were associated with the skills in category one. A portion of these students, 59 percent of the grand total, were also associated with skills in category two. Similarly, a subset of those in category two, 21 percent of the grand total, were also in the third category.

Table 2-7 shows similar proportions of students in Grade 4, Grade 7, and Math 10 associated with at least the level of skills for category one. These proportions ranged from 95 to 98 percent of the total number who wrote at each of those grades. On the other hand, only 78 percent of Math 10A students were associated with the skills for that course contained in category one. In subsequent categories the proportions of students in Math 10A were considerably lower than those in the other grades and course.

The knowledge and skills which clustered into each category, were different for each grade and course. Description of these are reported in subsequent chapters which provide results for each of Grades 4, 7, and 10.

References

Aitken, L.R. (1976). Update on attitudes and other affective variables in learning mathematics. *Review of Educational Research*, 46, 293-311.

Ministry of Education (1987). *Mathematics Grades 1-8: Curriculum Guide.* Victoria: Curriculum Development Branch.

Ministry of Education (1988). *Mathematics Grade 7-12.* Victoria: Program Development Division.

Phillips, R.B. (1973). Teacher attitude as related to student attitude and achievement in elementary school mathematics. *School Science and Mathematics*, 73, 501-507.

Robitaille, D.F. (Ed.) (1981). *The 1981 B.C. Mathematics Assessment: General Report.* Victoria: Ministry of Education.

Robitaille, D. F. & O'Shea, T .J. (Eds.) (1985). *British Columbia Mathematics Assessment 1985. General Report.* Victoria: Ministry of Education.

Taylor, A.. R. (1988). A study of relationships between classroom processes and achievement in mathematics at the Grade 7 level. *Research Forum*, 3, 37-44.

Taylor, A . R. & Robitaille, D.F. (1987). *Classroom Processes and Their Relationship to Achievement in Mathematics.* Victoria: Ministry of Education.

Chapter 3

Teachers of Mathematics

Valerie Overgaard
David F. Robitaille

Questionnaires designed to obtain information from teachers of mathematics were distributed to teachers whose classes were involved in the assessment. A total of 1980 Grade 4 teachers, 1692 Grade 7 teachers, and 912 Grade 10 teachers of mathematics responded to the questionnaires, representing the largest sample of teachers from which data have been collected in a provincial mathematics assessment. The numbers of teachers responding in the 1985 assessment were 1304, 1044, and 686 respectively.

The results are reported here in five sections corresponding to the subsections of the questionnaires: Background Information, Implementation Information, Classroom Practices, Mathematics in School, and Opportunity to Learn. Wherever possible and appropriate, data from previous assessments are displayed and comparisons drawn. In addition, where students were asked to respond to the same or similar items as teachers were, the student data are also reported here.

Structure of the Questionnaires

There were three versions of the teacher questionnaire for Grade 4, three for Grade 7, and two for Grade 10. The background and implementation items were common to all versions. Items in the Background Information section were intended to provide descriptions of the mathematics teachers in the province. Items dealt with gender, years of experience, professional activities, professional preparation, and perceptions of factors related to students' success in mathematics. The items in the Implementation Information section of the questionnaires were intended to obtain information needed to generate a composite picture of the curriculum as it is being implemented, to identify the extent of implementation support available for teachers, and to determine opinions generally held about the new curriculum. Items dealt with the usefulness of the curriculum guide, the appropriateness of the mathematics textbook being used, the availability of in-service programs, and the strengths or weaknesses of the curriculum.

Items in the Classroom Practices section were intended to provide information about teaching strategies, and students as well as teachers were asked to respond to these items. The items referred to examples of teaching strategies and questioned the frequency of their use during a typical school week. For each grade, it was intended that nine different strategies would be distributed across the various forms, and this was the case for the Grade 7 and Grade 10 questionnaires. Unfortunately, because of an error somewhere in the process, the same three examples were repeated on all three versions of the Grade 4 questionnaire.

The items in the Mathematics in School section concerned activities and topics specific to the grade level. Teachers were asked to rate each in terms of how important the topic was for the class, how easily it could be taught, and how much they enjoyed teaching the topic. The same items appeared in the student booklets. The intent was to be able to examine information about students' and teachers' perceptions of various mathematics topics, compare them, and relate them to achievement. The Grade 4 questionnaires had items about the same four

topics on each of the three versions. For Grade 7, there were items about 12 different topics and for Grade 10, nine different topics.

The final section of the questionnaires contained items dealing with Opportunity to Learn. These were modelled on the items developed for the Second International Mathematics Study (Robitaille and Garden, 1989). On each questionnaire a selection of items from the student booklets was displayed (20 on each version of the Grade 4 and Grade 7 questionnaires, and 25 on each version of the Grade 10 questionnaires). Items were selected to represent the various strands of the curriculum, but were more heavily weighted in areas of mathematics which have been given increased emphasis in the curriculum, such as data analysis and geometry. Teachers were asked to estimate the percentage of students in their class who would get each item correct other than by chance. They were also asked to indicate whether the mathematics needed to answer the item correctly had been taught or reviewed in a previous school year, in this school year, whether it would be done later this year or in a subsequent year, or whether it would not be done for reasons other than those listed.

Teacher Background

Gender

The proportion of female teachers of mathematics is at its highest in Grade 4 and it drops off sharply thereafter. The proportions of male and female teachers in Grade 4 (36 percent and 64 percent) are almost the inverse of those for Grade 7 (66 percent and 34 percent). By Grade 10, fewer than 20 percent of mathematics teachers are female.

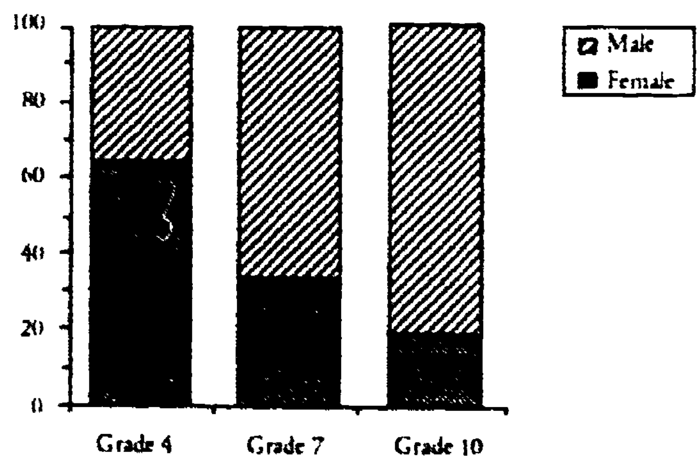
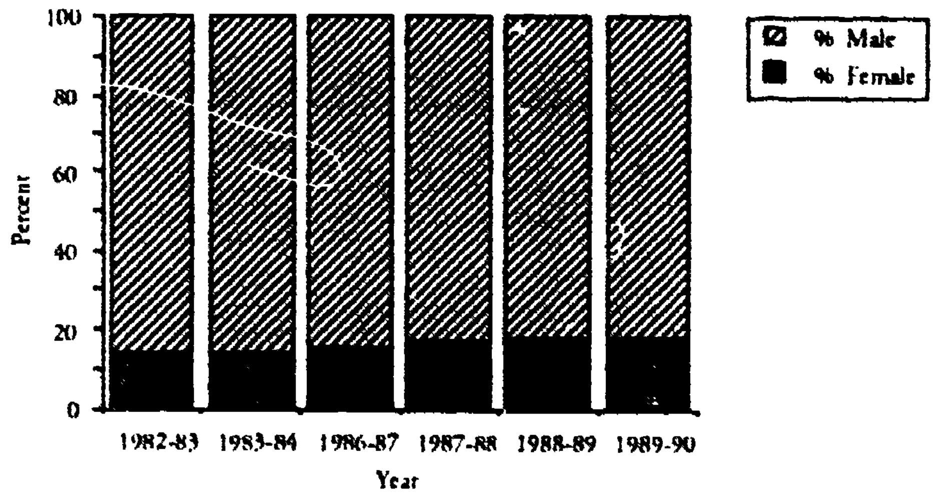


Figure 3-1. Distribution of males and females in the mathematics teacher population.

As the same information is not available from the 1985 assessment, a direct comparison cannot be made. Similar data from other sources, however, indicate a slight growth in the number of females teaching mathematics at senior levels. Figure 3-2 represents the secondary mathematics teachers head count by gender for the years 1982/83 to 1989/90 as recorded by the Ministry of Education.

This unequal representation of women teachers of mathematics is a seri-

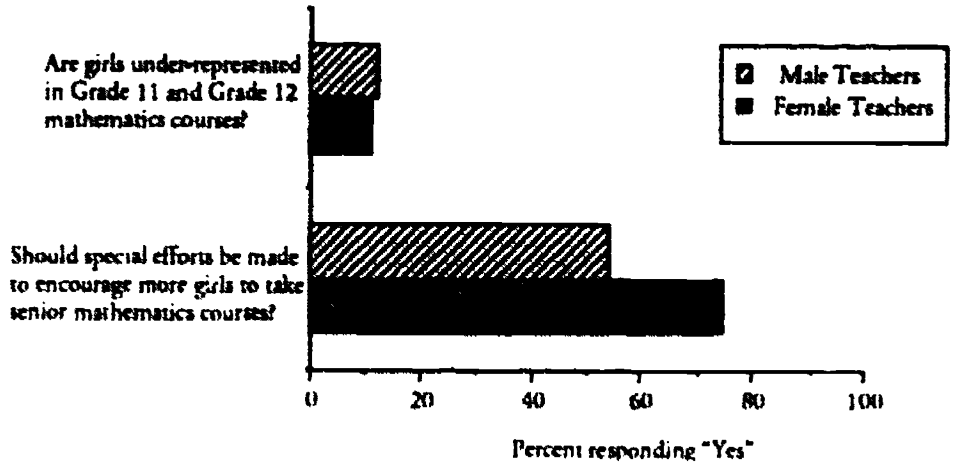
Figure 3-2.
Percent of female secondary mathematics teachers 1982-1990.



ous concern. The lack of female role models for young women in mathematics is one of the factors that contributes to their avoiding senior studies in the field (Isaacson, 1989). Interestingly, in the Second International Mathematics Study (SIMS) this unequal representation of female teachers in senior mathematics courses was evident in only some countries. In Hungary the female teachers significantly outnumbered the male; and, in the United States and Thailand, the difference between the number of female and male teachers was negligible. In the sample from British Columbia, however, 96 percent of the teachers were male: a proportion that was matched only by the sample from Japan (92 percent). As the study points out, there is certainly ground for investigating what societal pressures lead to such differences and what implications there are for mathematics education (Robitaille and Garden, 1989).

Grade 10 teachers were asked if they thought girls were under-represented in their Grades 11 and 12 mathematics classes and if they thought some special efforts should be made to encourage more girls to take senior-level mathematics courses. Of the 462 teachers responding "yes" or "no" to the issue of under-representation, 407 or 88 percent of the group thought there was no under-representation of girls in their senior mathematics classes. At the same time, 59 percent of all teachers responding thought special efforts should be made to encourage girls to take senior-level courses in mathematics. Data, reported by gender of the respondent, are shown in Figure 3-3. Interestingly, a slightly higher percentage of males consider there is an under-representation of girls in senior mathematics courses; yet, a much higher percentage of females said that special efforts should be made to encourage girls to take senior level mathematics courses. The data present somewhat of an anomaly as well. Whereas only 47 males and 11 females identified under-representation of girls as a problem, 368 males and 124 females thought special efforts should be made to encourage more girls into senior mathematics classes. Presumably teachers answered the first question with regard to their own specific situations and to the second thinking in the more abstract terms of the problem.

Figure 3-3. Percent of teachers responding "Yes" to questions about the participation of girls in senior mathematics courses.



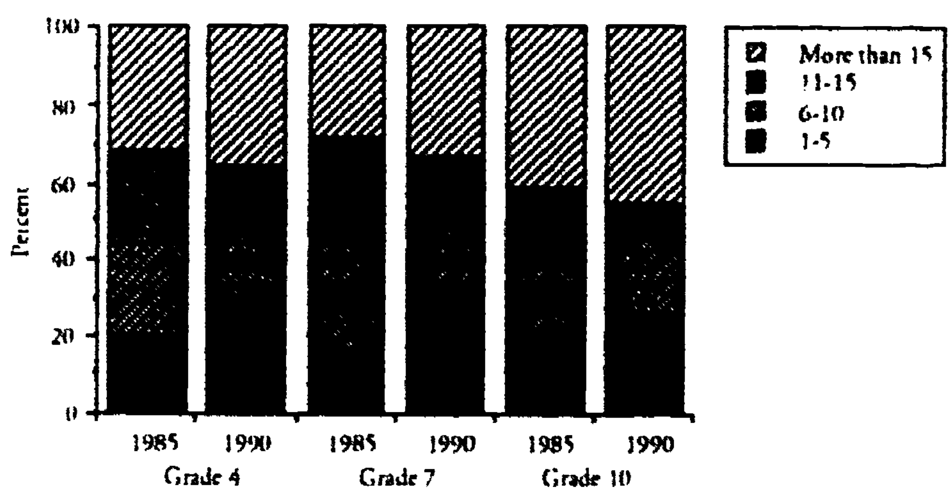
When asked to identify reasons why girls might be under-represented, few respondents selected any of the choices offered. The highest response rate, 37 responses (26 males and 11 females) identified girls' thinking they are not good in mathematics as a reason for their under-representation. Response rates to the other reasons listed were as follows: girls see no use for mathematics outside school 30 responses (25 male and 5 female); peer pressure is against taking mathematics, 24 responses (17 male, 7 female); girls don't like mathematics, 23 responses (17 male, 6 female); girls think mathematics is not feminine, 13 responses (9 male , 4 female); and teachers discourage girls from taking mathematics, 13 responses (10 male and 3 female). One would have expected higher response rates to these items. The factors listed have been identified in the literature as important contributing factors to the underachievement and unequal representation of girls in senior mathematics courses (Royal Society and the Institute of Mathematics and its Applications, 1986) and studies have shown some intervention strategies to be successful in alleviating the problems (Fennema, 1981).

Female participation rates, according to Ministry of Education course enrollment data, are almost equal to that of males. For senior mathematics courses in 1988, 59 percent of the females and 57 percent of the males enrolled in Algebra 11; the corresponding percentages for Algebra 12 are 29 percent and 34 percent respectively. Provincially, classes represent a male to female ratio of 0.98 in Algebra 11 and 1.18 in Algebra 12. This information appears to belie the problem of a lack of female role models, but it may simply be that this course is a requirement for many post-secondary options and that it is later that the largely unequal proportions begin to show. Enrollment statistics from the Faculties of Science and Arts at UBC lead one to this conclusion. In 1988-89, female students in undergraduate programs in the Faculty of Science were outnumbered by their male counterparts at a rate of close to two to one (2385 male, 1427 female) and in graduate programs there were almost three times as many males (528 male, 183 female). At the same time the Faculty of Arts reported almost the opposite distribution, with 2592 male and 4142 female undergraduate students, and 359 male and 404 female graduate students (UBC Fact Book, 1989).

Teaching Experience

The numbers of years of teaching experience for mathematics teachers has changed considerably since the previous assessment. The data are displayed in Figure 3-4.The figures indicate a significantly higher proportion of mathematics teachers in the upper range of experience at all grade levels. This number has also grown over the last two assessments. At the same time, there is an increase in the number of teachers new to mathematics teaching at all grade levels since 1985. It would appear that the bulge of teachers in the middle ranges of experience are pushing up to the higher range. In the higher range, as a significant number of teachers reach retirement age, more opportunities for new teachers in the field are created. Early retirement schemes made available over the intervening years may have some bearing on these figures. This factor combined with an increase in student enrollment in many parts of the Province as well as reduced pupil teacher ratios, indicates there will likely be a continuing trend towards the hiring of new teachers. With changes being implemented in all areas of the school curriculum, the influx of recently trained teachers in greater balance with those with experience should prove to be a benefit.

Figure 3-4. Years of mathematics teaching experience.



Professional Activities

Membership in the three major professional organizations for mathematics teachers has remained relatively stable over the last decade. Membership in the National Council of Teachers of Mathematics (NCTM) remains low for elementary teachers and has maintained its level in the case of Grade 10 teachers. Two new categories were included in the list of associations. They were the *Association Provincial des Professeurs de l'Immersion et du Programme-Cadre* and "Other professional associations." The inclusion of these two is no doubt the reason for a significant decrease in responses in the "None of the above" category. It is encouraging to note that more than 60 percent of teachers at all three grade levels belong to a professional association. (One can only assume, given the list of options, that teachers are not including in their responses to this item, their general membership in the BCTF in the category of "membership in other professional

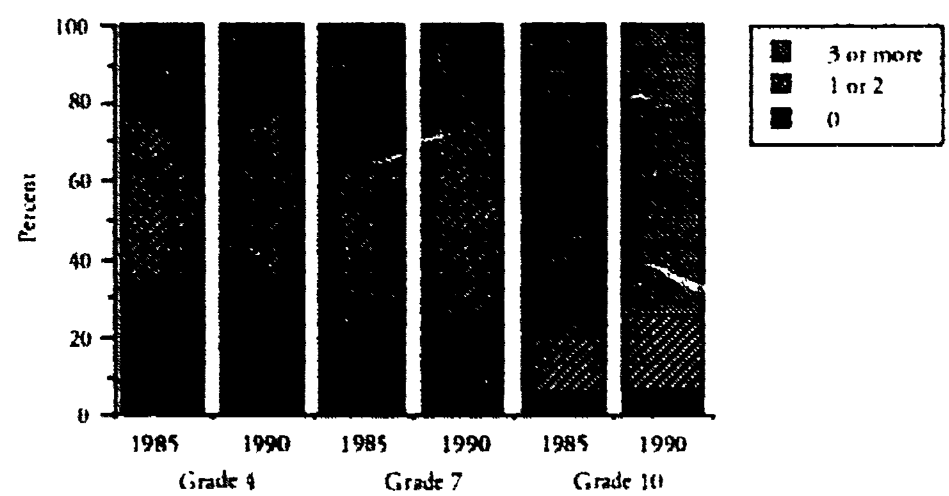
associations.")

Sixty percent of teachers at all grade levels reported they do not read professional journals frequently. Response at all grade levels was very similar. Thirty-seven percent of Grade 4 teachers indicated they read a professional journal frequently (at least one a month). 46 percent said they read one sometimes (fewer than one a month), and 17 percent said they read one rarely. The corresponding percentages for Grade 7 teachers was 41 percent frequently, 42 percent sometimes, and 18 percent rarely. In Grade 10 the response was: 36 percent frequently, 40 percent sometimes, and 24 percent rarely.

Teacher Preparation

Teacher preparation was measured in terms of the numbers of postsecondary mathematics courses teachers have taken. The two categories of courses listed were mathematics and mathematics methods (pedagogy). A course was defined as being the equivalent of three classes per week for a semester.

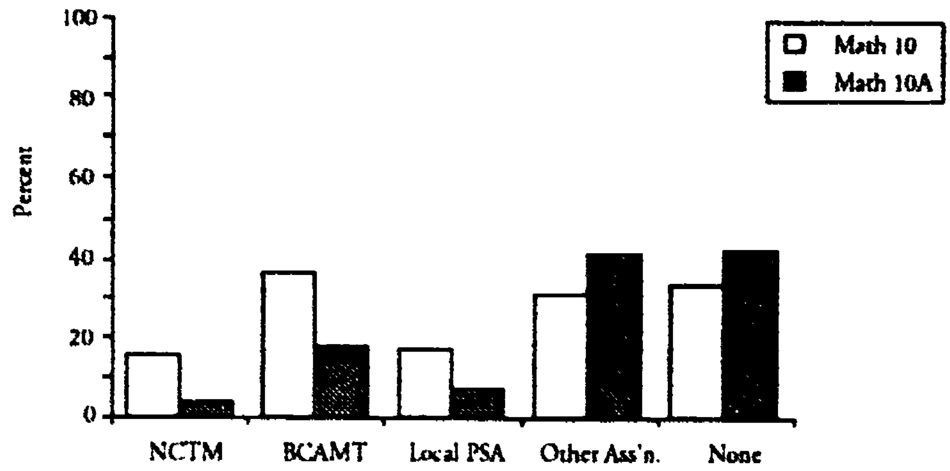
Figure 3-5. Number of postsecondary mathematics courses (mathematics content and pedagogy) taken.



At all grade levels there has been an increase in the number of teachers who have taken one or two postsecondary mathematics courses. Although this is promising, there is also a slight increase in the number of teachers at the Grades 7 and 10 levels who have had no mathematics courses. These numbers are high enough to be considered a problem: 25 percent of teachers of Grades 4 and 7 mathematics have had no postsecondary mathematics courses and a similar number have had no methods courses in mathematics. In the case of Grade 10 teachers, 6 percent have had no postsecondary mathematics courses; this figure represents an increase of 1 percent over the 1985 response in this category.

The data on professional activities and professional preparation for Grade 10 teachers were analyzed for those who taught Mathematics 10, those who taught Mathematics 10A, and those who taught both. The results of these analyses are illustrated in Figures 3-6, 3-7, and 3-8.

Figure 3-6. Membership in professional associations: Grade 10 teachers.



The amount of professional activity in mathematics, as reported under categories of membership in professional associations and reading of professional journals, is considerably less for Mathematics 10A teachers. As well, the number of postsecondary mathematics courses taken by them is much lower. This should be of some concern to educators in the province. The rationale for having an alternate course for students in Grade 10 was to account for the varying abilities of students. It was deemed important to provide an additional year of mathematics instruction for students who required extra time to learn. Hence Mathematics 10A attracts students who wish additional assistance with the academic mathematics program. Presumably teaching these students would be a challenge requiring the utmost in preparation and teaching ability. If teachers assigned to these courses are not among the most professionally prepared mathematics teachers, then there is a problem that needs some careful consideration and attention.

Figure 3-7. Academic and professional preparation of Grade 10 mathematics teachers.

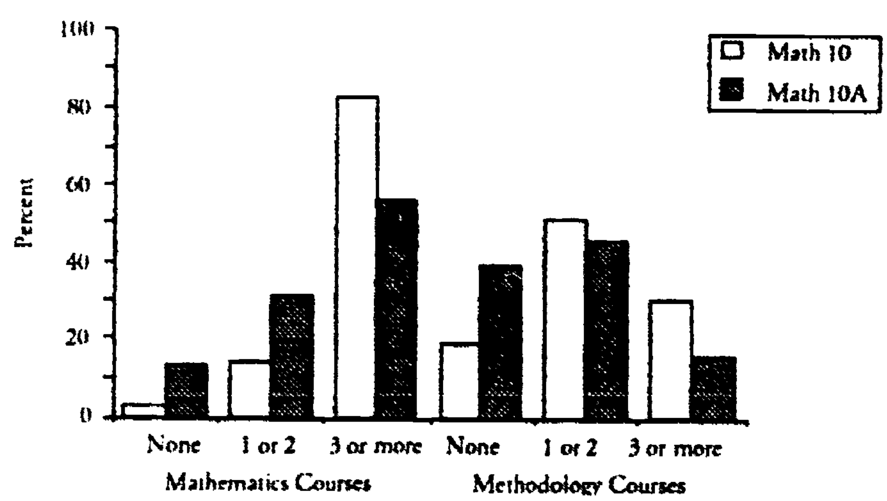
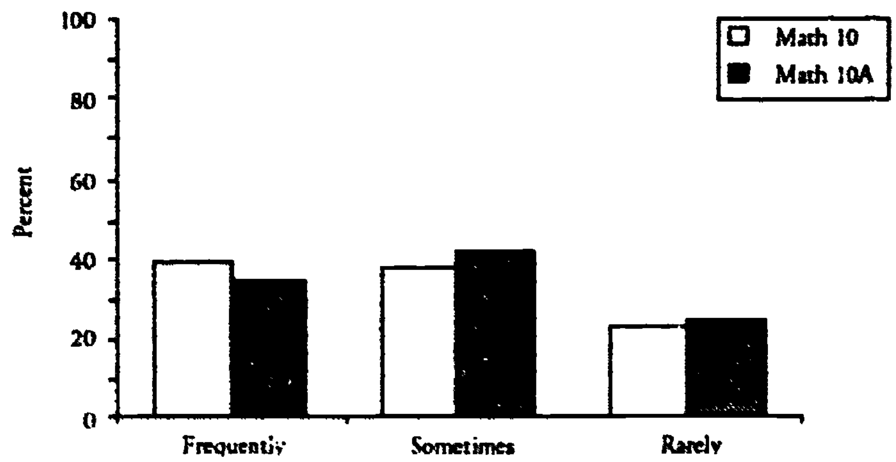


Figure 3-8. Frequency of journal reading: Grade 10 teachers.



Factors Affecting Student Success

Of nine factors which could be used to explain why some students do not make satisfactory progress in mathematics, indifference or lack of motivation was ranked as a very important factor by the highest proportion of teachers at all grade levels. It is interesting to see the growth in importance attached to lack of motivation as the grade levels increase. While teachers of all the grades see it as important, it is identified as a very important factor by significantly more teachers at the Grade 10 level. Similarly, student absenteeism is seen to be a problem for a greater number of Grade 10 teachers. These are most likely comments on the student group at each grade. Statistics on the drop-out rate of students as they reach Grade 10 indicate that students at that level appear to be less motivated generally and more likely to be truant (Radwanski, 1987).

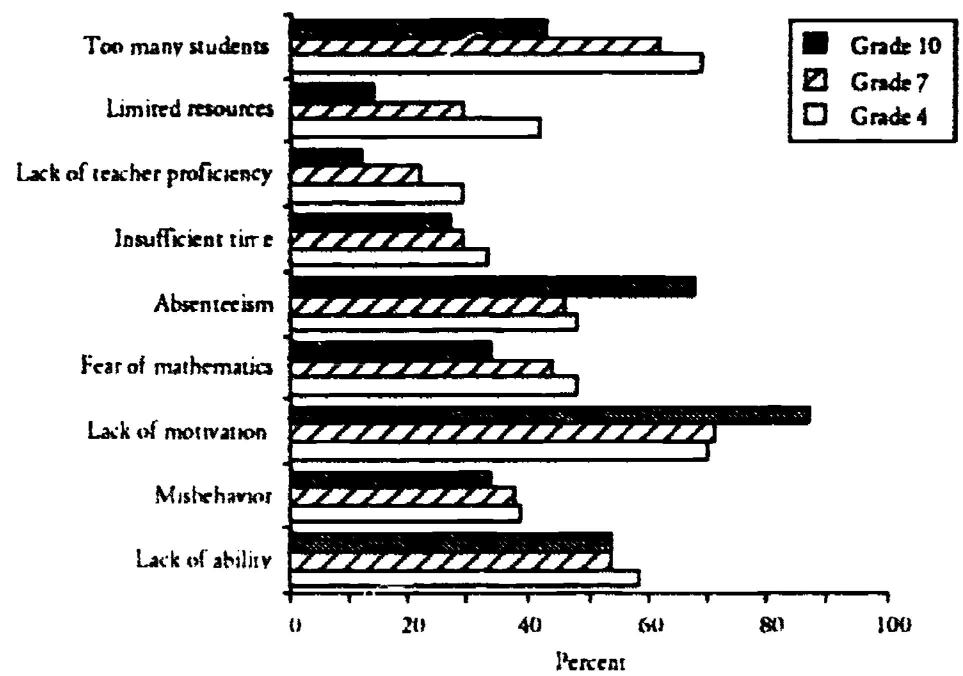
Not surprisingly, there is considerable agreement among teachers of the three grades that lack of ability is an important factor in students' lack of progress in mathematics. At all three grade levels, more teachers perceive ability to be more important than most other factors.

Responses to the importance of teaching proficiency differ considerably from grade to grade. This should be considered in light of responses to the items on teacher preparation. The response bears a direct relationship to the number of post-secondary mathematics courses taken by teachers at each grade level and may well reflect an attendant level of confidence in ability.

While not surprising, it is cause for some concern that teachers view students' ability to be so much more important than other factors such as their own proficiency. Teachers who explain students' success mostly in terms of student ability are not likely to be critical of classroom practice or the curriculum and would more likely see the lack of success of students as beyond their control. Data from the same items collected in the Second International Mathematics Study (Robitaille and Travers, in press) is quite different for the various countries partic-

ipating. In Japan, for example, teachers were much more likely to search for causes of students' failure in themselves and to question the efficacy of their teaching practices than to place the blame on student ability. At the same time, in measures of mathematics achievement, Japanese students outranked their counterparts in most countries of the world.

Figure 3-9. Teachers' perception about the importance of factors that may affect student success.



Fewer Grade 10 teachers than those in the other two grades see fear of mathematics as an important explanation for students' lack of progress. This is surprising in light of recent research. An analysis of the results of 151 studies of mathematics anxiety indicated fear of mathematics is consistently related to lower mathematics performance and that anxiety increases through junior high and peaks near Grades 9 and 10. As well, in Grades 5 through 12, anxiety is associated with girls more often than boys. There is no compelling evidence that poor mathematics performance causes fear of mathematics (Hembree, 1990). The difference in perception between teachers in elementary grades and secondary grades may be a reflection of the teachers' own level of confidence in mathematics. Those who have experienced their own fear of mathematics would be more likely to see it as an important factor for others. Those with specialties in mathematics, as is often the case with secondary teachers, would not likely have experienced the fear themselves and therefore may not recognize it as a factor for others. As research indicates the fear can be ameliorated with good intervention strategies, it is important to be able to identify this attitude in students.

Class size, predictably, is seen to be an important factor in students' success. It is seen to be so by more teachers of Grades 4 and 7 than teachers of Grade 10. This could be related to the different teaching strategies employed with younger students. It may also be associated with the trend for streaming students according to some measure of ability in Grade 10 mathematics classes.

Insufficient time for mathematics is identified as important by less than a third of the teachers in each grade, making it one of the least important factors for students' success reported by teachers. This seems a curious perception. Mathematics is a complex subject to learn. It involves many abstract concepts. Students often take greater periods of time and more exposure to a variety of learning situations to assimilate some of these abstract concepts. It would seem logical to view quality time spent in class as an important factor for student progress and studies do confirm that logic (Walberg, 1984). On the other hand, other data from this assessment indicate time allocated for mathematics is becoming a smaller portion of the instructional day. As well, teachers at all levels reported that there was too much material to be covered in the new curriculum. There seems to be a contradiction involved in these different findings.

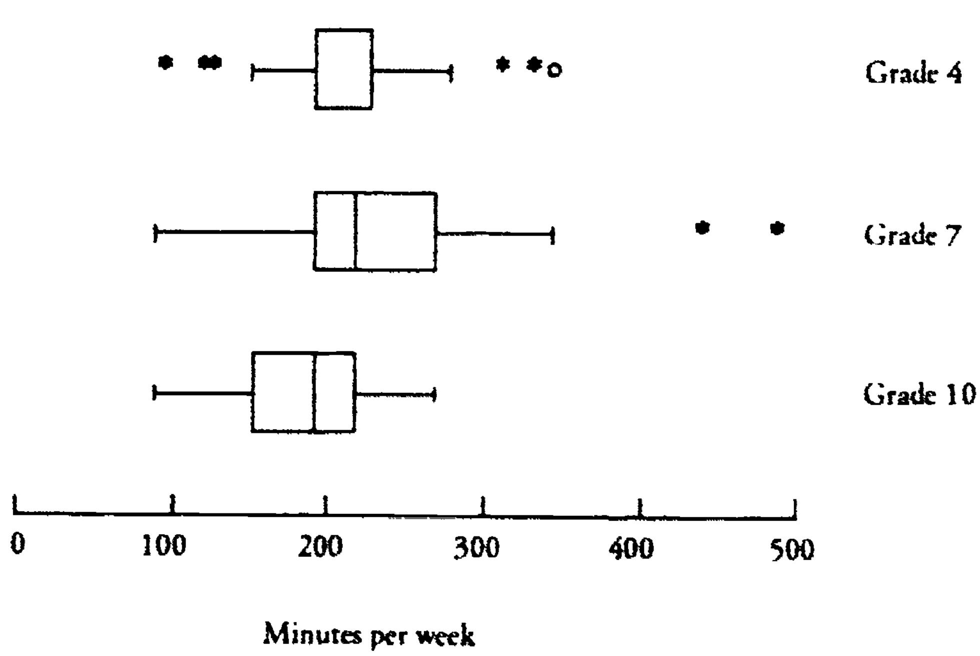
Limited resources are not seen to be very important by most teachers at all three grade levels, though it is important to note the higher response to this factor at the Grade 4 level. This may reflect the perceived value of manipulative materials in the early grades, and their limited availability. In a subsequent item about mathematics materials, 37 percent of Grade 4 teachers disagreed or strongly disagreed that materials were easy to obtain. Only 30 percent and 28 percent of Grades 7 and 10 teachers responded negatively to the same item.

Implementation Information

Instructional Time

Data provided about the length of mathematics classes and the number of classes taught each week were combined to estimate the total number of minutes spent on mathematics instruction each week. These data are reported in Figure 3-10. The data are interesting in at least two ways. First there is a tremendous range of time spent on mathematics within each grade level. Secondly, particularly in Grades 7 and 10, a number of teachers report very small amounts of time spent on mathematics.

Figure 3-10. Number of minutes of mathematics instruction per week.



Grade 4 teachers report they spend between 135 and 275 minutes per week teaching mathematics. The highest percentage (79 percent) said they had a mathematics class each day, and 95 percent of teachers said the classes were between 30 and 60 minutes long. The same information was collected in the 1985 assessment. At that time, more teachers reported daily mathematics classes (84 percent) and more teachers reported their classes were between 30 and 60 minutes (98 percent). It appears that less time is being spent on mathematics in this assessment period. The data in Figure 3-10 show a few outliers represented as asterisks. These represent teachers whose responses were significantly different from the vast majority reporting. For example, on the one end, a teacher reports less than 100 minutes of mathematics instruction and at the other a teacher reports more than 300 minutes of mathematics instruction.

Grade 7 teachers reported a much greater range: between 80 and 340 minutes (not including the outliers, one of whom reports more than 475 minutes of mathematics instruction per week). It is both surprising and alarming to note that some Grade 7 teachers spend little over one hour a week on mathematics and that 25 percent of Grade 7 teachers spend less than 200 minutes on mathematics each week. These data may explain responses in other sections of the questionnaire where teachers express some concern about the amount of material to be covered. Most teachers (71 percent compared to 74 percent in 1985) report daily mathematics classes. The greatest number (96 percent compared to 97 percent in 1985) say their classes are between 30 and 60 minutes each.

Grade 10 teachers report a range of 80 to 265 minutes per week devoted to mathematics instruction. As is the case with the Grade 7 results, the small amount of time spent on mathematics in some grade 10 classrooms is of concern. Most Grade 10 teachers (64 percent) reported they had 3 mathematics classes per week and 88 percent said their classes were between 45 and 60 minutes long. The trend may also partially explain the results for a subsequent question in this section where teachers were asked about the appropriateness of the amount of material to be covered in the new curriculum. Thirty-two percent of Grade 4 teachers, 38 percent of Grade 7 teachers, and 43 percent of Grade 10 teachers said they disagreed or strongly disagreed that the amount of material was appropriate. There is considerable consensus that there is too much material in the curriculum at each grade level.

Program Implementation

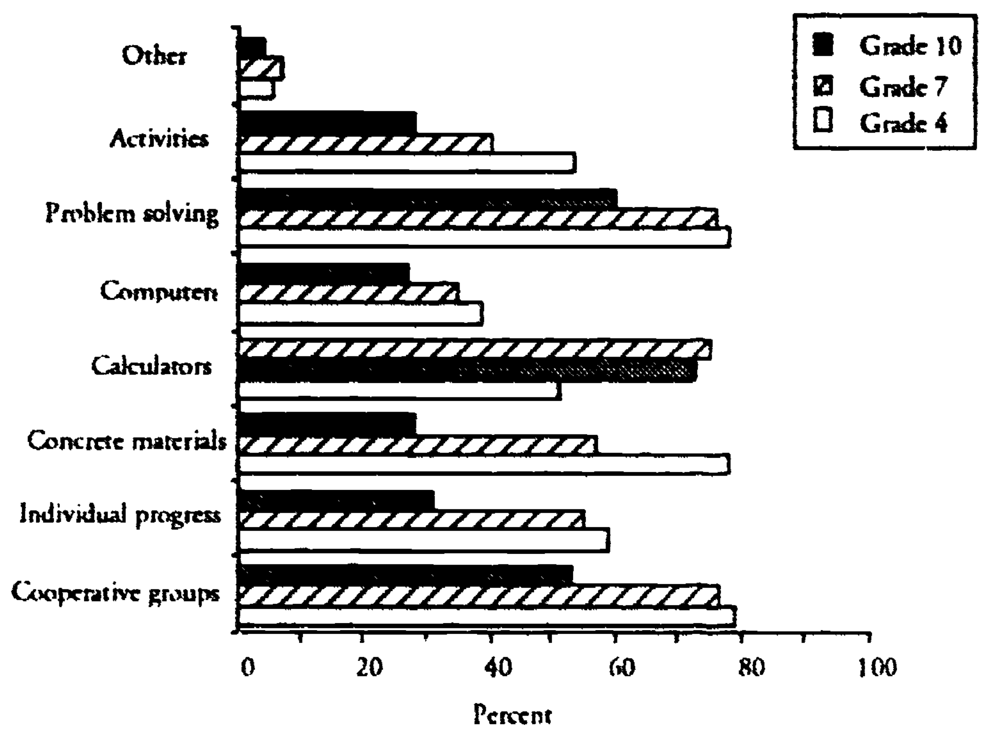
The revised provincial mathematics curriculum was implemented over a period of three years, with some schools choosing to adopt the program in its optional year and with the secondary programs a year behind the elementary in the implementation schedule. Responses to the question of how long the new curriculum had been in use at each grade level reflect this varied schedule. Over 40 percent of elementary teachers (45 percent in Grade 4 and 43 percent in Grade 7) have been using the new mathematics curriculum since it was released (1987). It is somewhat surprising that over 3 percent of the teachers responding from elementary schools indicate the school is not using the new curriculum. In Grade 10, 66 percent of classrooms have been using the new curriculum for two years, 19 percent for three or more years, and 14 percent for one year. Only one percent

of Grade 10 teachers reported that their schools were not using the new curriculum.

Teaching Practices

Most teachers at all grade levels believe that their approach to teaching mathematics has changed over the last three years, the years coinciding with the implementation of the new curriculum. Seventy-eight percent of Grade 4 teachers, 76 percent of Grade 7 teachers, and 69 percent of Grade 10 teachers responded in the affirmative to an item about changes in practice.

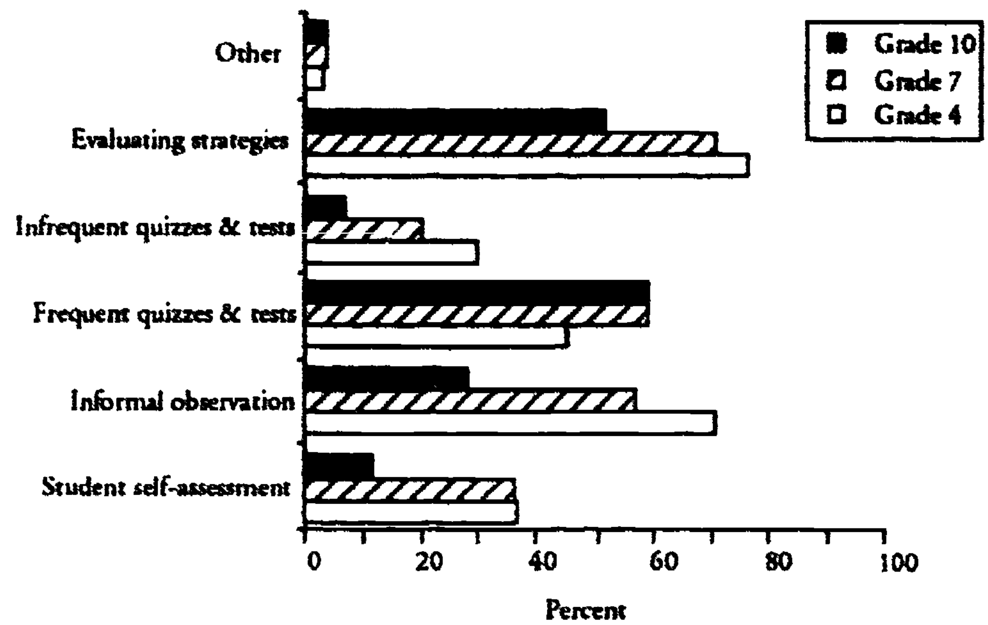
Figure 3-11. Specific strategies reflecting change in approach to mathematics teaching.



Teachers most often named cooperative learning and problem solving as the two strategies reflecting their changed approaches to teaching. In Grade 4, use of concrete materials was named as often, while in Grade 7, use of calculators competes for the most often named changed strategy. The use of calculators was the most frequently selected strategy of Grade 10 teachers. Teachers of Grade 4, however, identified use of calculators least often as one of their changes in approach. This is consistent with attitudes expressed in the 1985 assessment about the use of calculators when the majority of teachers of younger students indicated they thought calculators were not appropriate at that level.

Along with teaching strategies, teachers were asked if their evaluation strategies had changed over the last three years. There was a positive response in this area in Grades 4 and 7, with 57 percent and 53 percent answering in the affirmative. In Grade 10, only 47 percent of the teachers said "Yes." The common trend among the three grade levels was increased attention to evaluation of problem-solving strategies. This is congruent with the reported increase in attention to teaching problem-solving processes, and the results reinforce each other.

Figure 3-12. Specific strategies reflecting change in evaluation approaches.



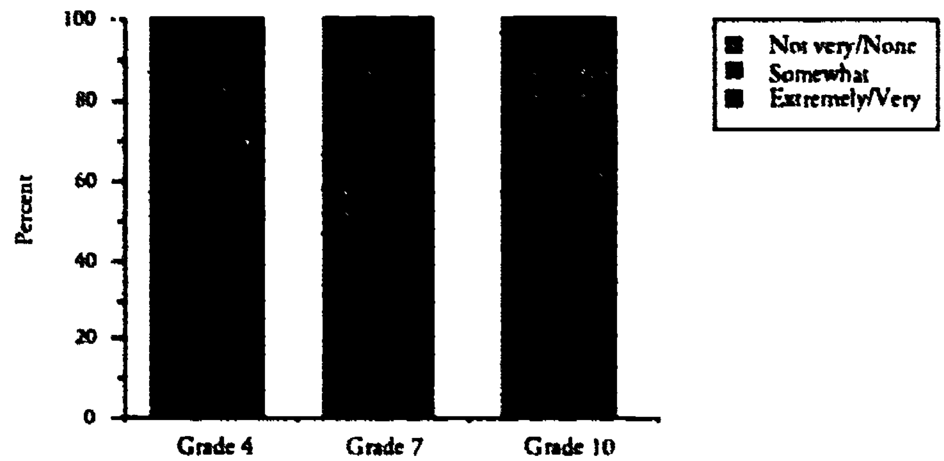
It is interesting to note that self-assessment was identified as a change in approach by 36 percent and 38 percent of Grade 4 and 7 teachers respectively, while only 12 percent of Grade 10 teachers identified this strategy as one they have recently adopted. It is always difficult to interpret responses that indicate a quantitative change (i.e. "more likely to use") when there was no baseline provided. It may be that Grade 10 teachers, because of their older student population, have been involving students in self-assessment for some time, thus no change would be reported. On the other hand, if this number indicates that Grade 10 teachers are just not likely to involve students in self-assessment, then a different set of conclusions should be drawn.

It is reasonable to conclude from the information provided in Figures 3-11 and 3-12 that teachers of mathematics in the province feel they have made considerable changes in their teaching and evaluation strategies. The strategies more likely to be used are those currently promoted as effective for students' learning. While one cannot draw the conclusion that the new curriculum is responsible for these changes, it is certainly true that the changes are philosophically congruent with the new curriculum.

Curriculum Materials

It is clear that teachers consider the revised mathematics curriculum guides to be useful. Less than 10 percent of respondents at each grade level felt the guide did not provide any assistance for planning mathematics instruction. The style of the new guides represents an enormous change over the previous editions. The guides are much more detailed, and include more specific learning outcomes and limiting examples. Grades 4 and 7 teachers use the same guide (Grades 1-8) while Grade 10 teachers have a different one (Grades 7-12). Both have the same general layout. There is considerable consistency in the results at the three different grade levels as shown in Figure 3-13.

Figure 3-13.
Usefulness of mathematics curriculum guides.



There seems to be a good deal of satisfaction, as well, with the text materials selected for the mathematics curriculum. At each grade level fewer than 13 percent of the teachers indicated a disagreement with the positive statements made about the match and suitability of text for the curriculum and the students.

Figure 3-14.
Mathematics text in use.

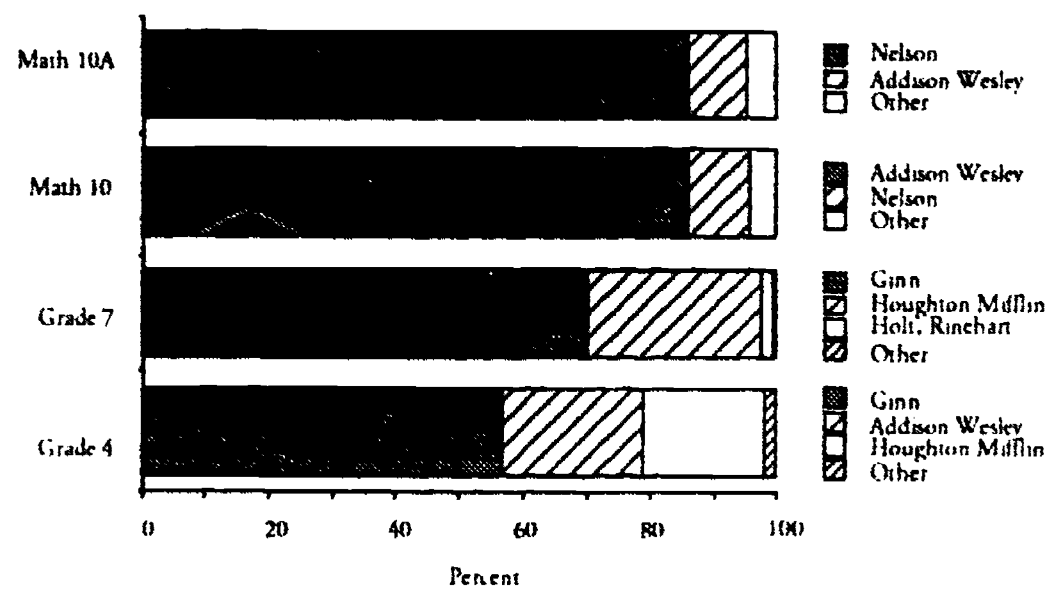


Figure 3-15.
Degree of match between text and curriculum.

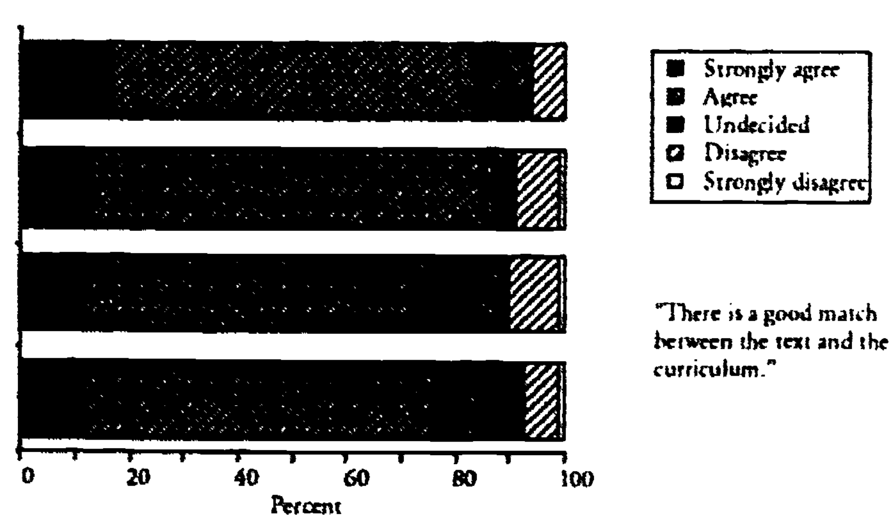
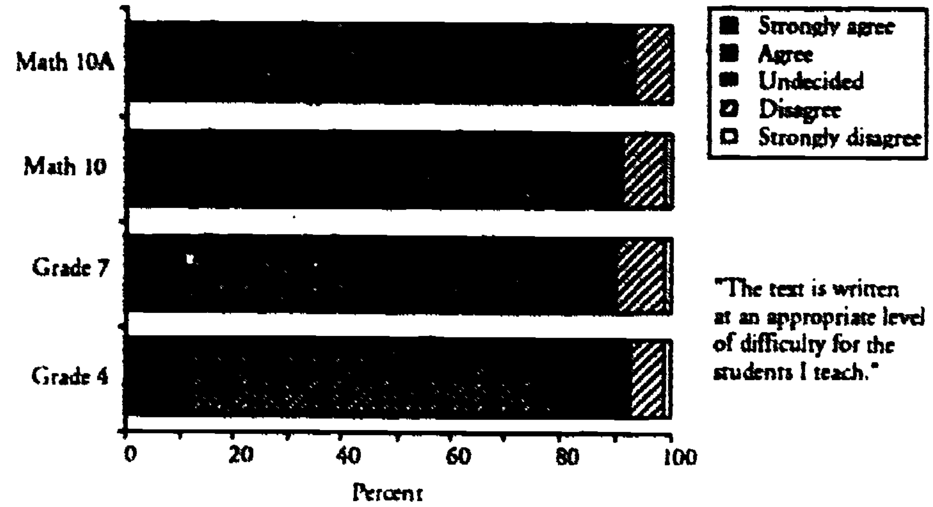
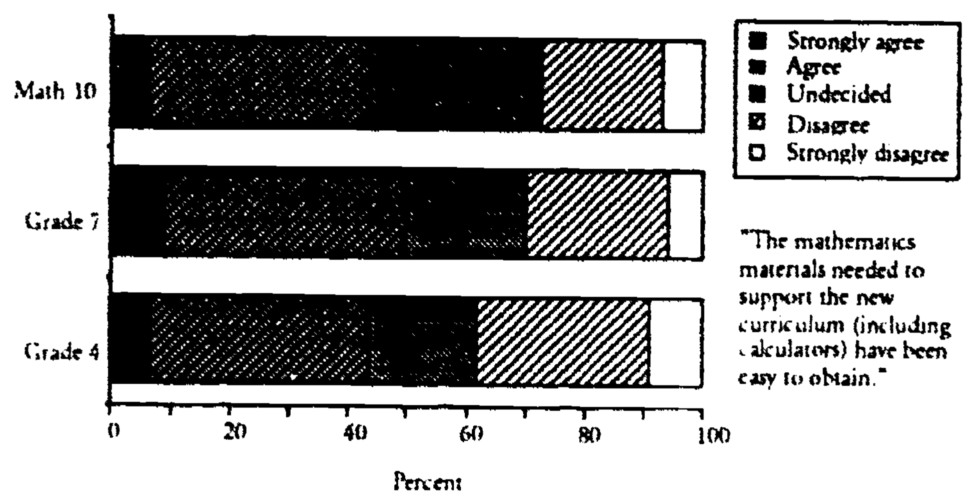


Figure 3-16. Appropriateness of text for student population.



Information collected about availability of materials needed to support the curriculum (including calculators) indicate that there is a lower level of satisfaction in this area. As shown in Figure 3-17, almost as many teachers disagreed or strongly disagreed as did agree or strongly agree that materials were easy to obtain.

Figure 3-17. Availability of materials to support curriculum.



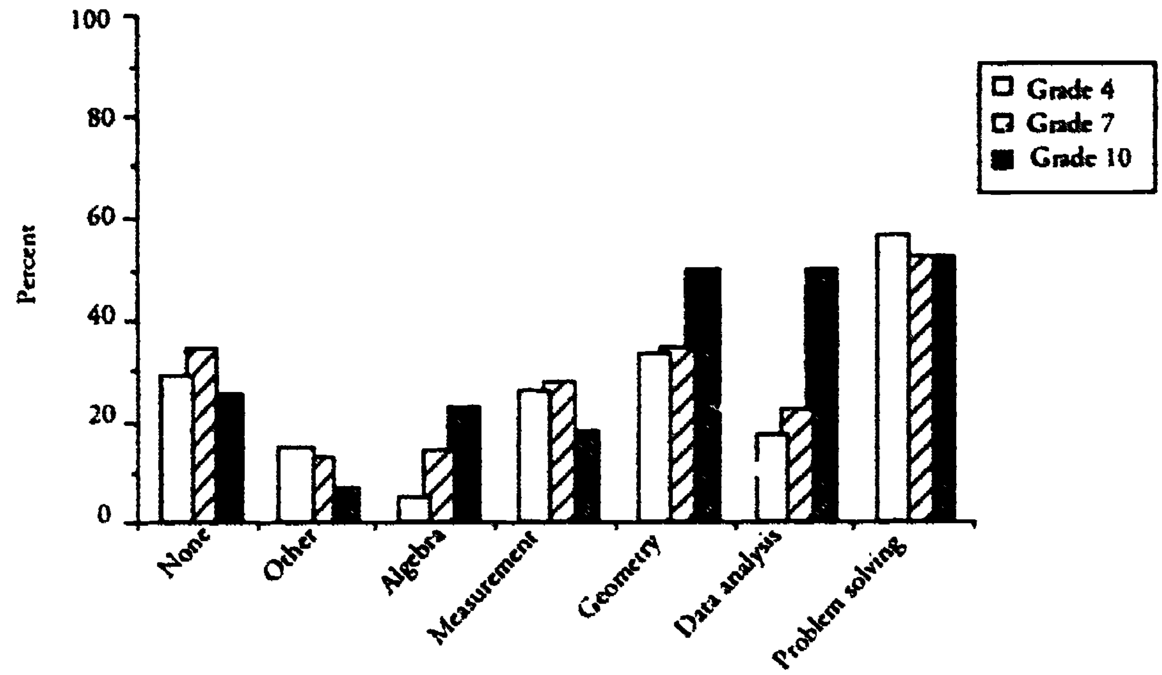
In-service Opportunities

There appears to have been considerable activity in terms of in-service to support the new curriculum, though teachers generally feel it was inadequate.

Given what the research says about the place of in-service in effective implementation plans, it is surprising to see the relatively few kinds of programs of which teachers were aware. More than 25 percent of teachers at all grade levels were not aware of any in-service programs being offered by the Ministry, the school district, the school, or any other sponsor.

The data indicate that the greatest availability was in the area of problem solving and it is tempting to attempt to link these data with the teachers' reports on their changing strategies in teaching. While a cause-and-effect relationship can

Figure 3-18. Teachers' awareness of the availability of in-service programs.

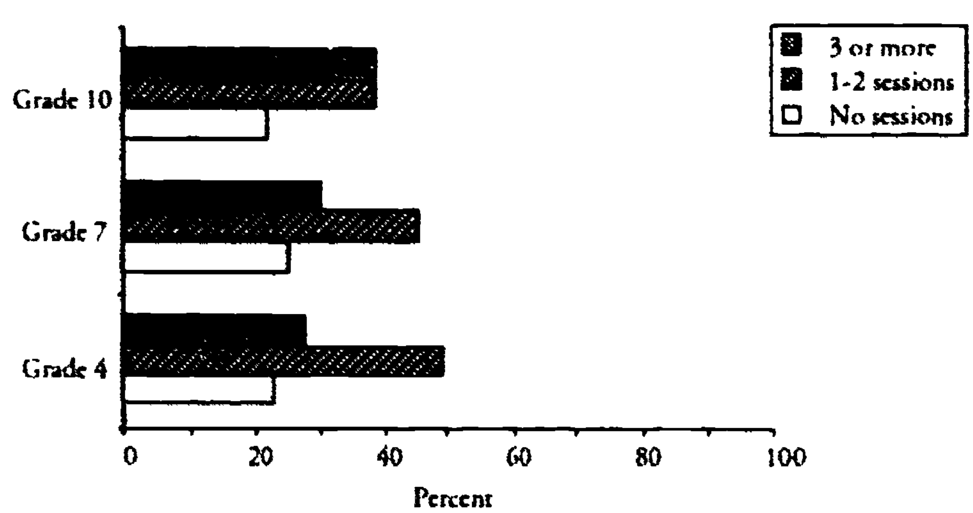


by no means be concluded, there is certainly cause to note that the greatest number of teachers report their change in approaches to teaching mathematics can best be reflected in the statement "I am more likely to focus on problem-solving processes."

Programs which were consistently reported as having the least availability were in the areas of data analysis, algebra, and measurement. As two of these are new areas for the Grades 4 and 7 curriculum, it is somewhat dismaying to note that in-service was not seen to be more readily available. This information is interesting in light of data from the Opportunity to Learn section where teachers frequently indicated that the required mathematics in data analysis for items on Grades 4 and 7 student questionnaires had not been taught.

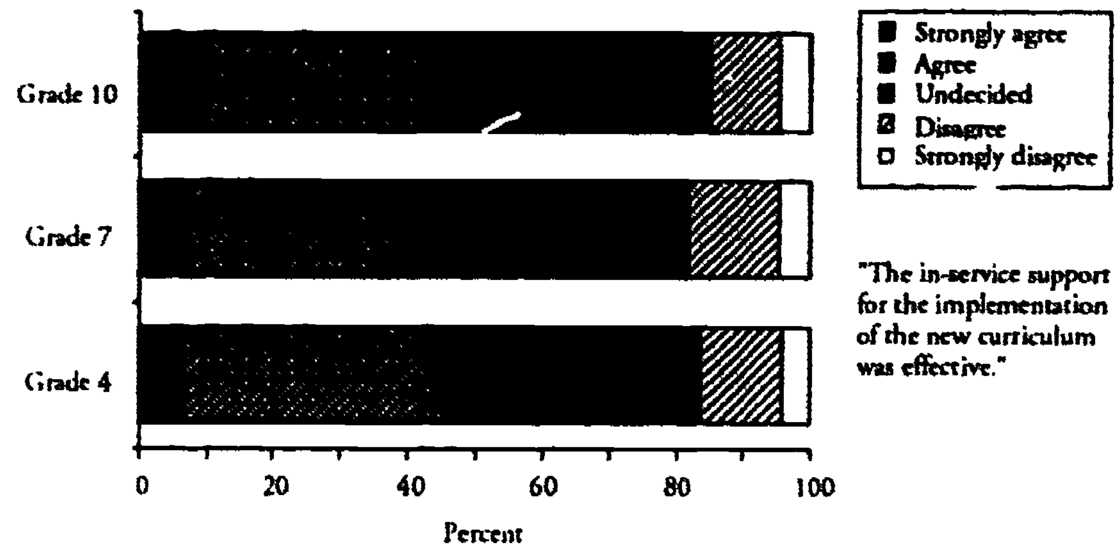
Actual attendance at in-service programs is fairly high; nonetheless, almost 25 percent of teachers at each grade level indicated they had not attended any in-service program. As the curriculum is substantially changed, this could represent a problem.

Figure 3-19. Participation in in-service programs.



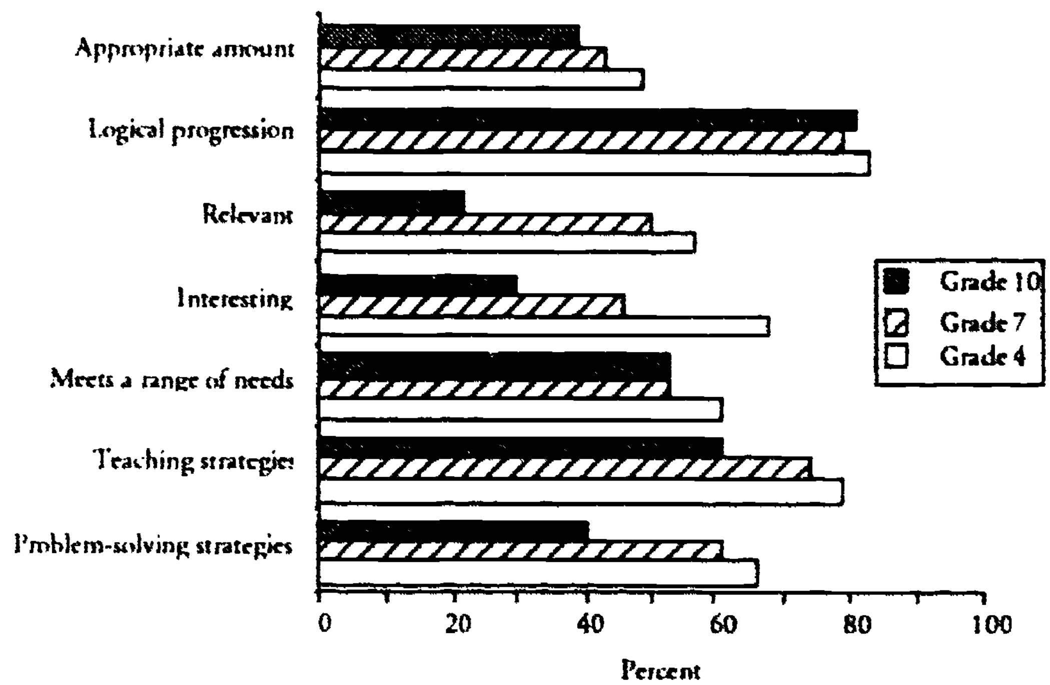
Telling information was obtained from the item asking teachers to rate the effectiveness of implementation support. Fewer than half the teachers in each grade indicated they thought the in-service support was effective. This represents a summative statement for the composite picture of implementation support for the new mathematics curriculum. Yet it would appear that, in spite of this shortcoming, teachers are relatively happy with the new curriculum itself and have adopted new strategies of teaching that are consistent with its philosophy.

Figure 3-20. Effectiveness of in-service support.



The mathematics curriculum at each grade level was reported to represent many strengths, and teachers identified most characteristics of the program as positive. This is especially true in Grades 4 and 7, where in most cases fewer than 10 percent of the teachers either disagree or strongly disagree with positive statements made about the curriculum.

Figure 3-21. Percent of teachers who agree on strengths of the new curriculum.



The one great exception to the overall positive response concerns the amount of material to be covered. Many teachers disagreed that it is an appropri-

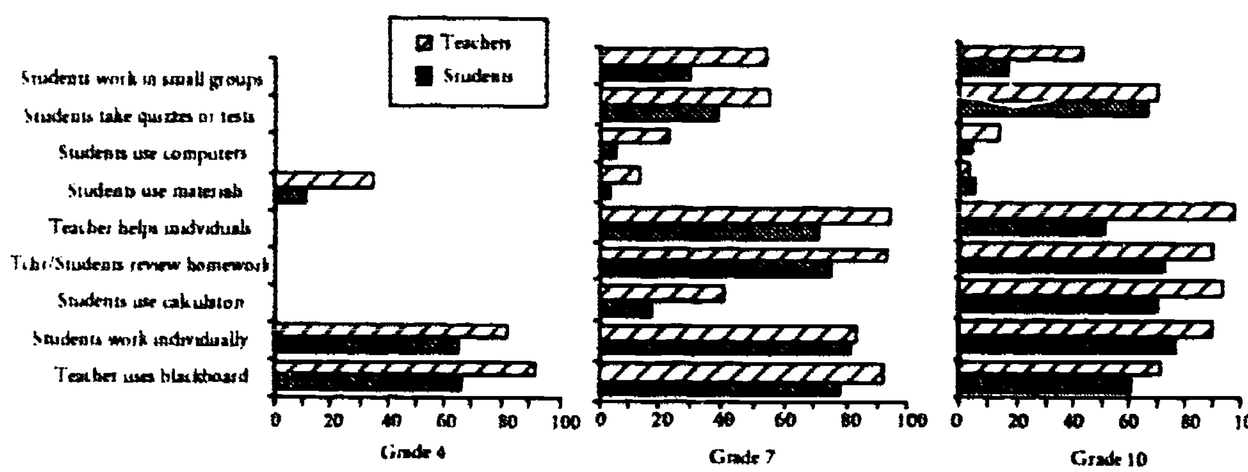
ate amount. This item did not ask whether "inappropriate" meant too much or too little but information collected from the Opportunity to Learn section, where teachers reported that a large part of the curriculum had not yet been taught (and this assessment was conducted in May of the year) would indicate that it means too much.

Reactions to the curriculum are somewhat less positive for Grade 10 teachers. In many cases the majority of Grade 10 teachers were undecided. This may be a result of the relatively short time the curriculum has been implemented in many secondary schools.

Classroom Practices

Grade 4 teachers were presented with three different classroom practices and asked to indicate how often they would engage in these practices in their mathematics classes in a typical school week. As previously noted, all Grade 4 teachers had the same three teaching strategies to consider. Grade 7 and Grade 10 teachers responded to nine different classroom practices. These were distributed over the different versions of the questionnaire, so that in Grade 7, any one teacher would only have three practices on which to comment, and in Grade 10, only five. Students in all grades were asked to respond to the same items. Figure 3-22 displays the data from all the forms.

Figure 3-22. Classroom practices in Grades 4, 7, and 10 as reported by teachers and students (Responses in categories "almost every day" or "often").



It would appear from the limited information Grade 4 teachers were able to provide, that on most days, mathematics classes would involve them explaining things to the class with the help of blackboard or overhead projector. Most classes would also include students completing individual seatwork. It is interesting to note that only a third of the classes would involve students working with manipulative materials. Almost 20 percent of teachers reported they rarely or never use manipulative materials.

Just as teachers of Grade 4 reported, teachers of Grades 7 and 10 said they spend a great deal of time speaking to classes and using the blackboard or overhead projector for explanations. These data are much like that collected in 1985, where teachers at all grade levels said that the highest proportion of time spent in class involved their explaining new topics or supervising computational drill. Similarly, students working individually on seatwork is a common activity in all mathematics classes as it was in 1985, when about 70 percent of teachers at

all grade levels reported that between 26 and 75 percent of time was spent with students completing seatwork. Reviewing homework has remained an activity consistently undertaken in most mathematics classes. Teachers helping individuals with their work is also consistently named as a common activity. Looking at the activities which received the highest responses, it appears that mathematics classes typically involve the teacher reviewing the previous day's homework, explaining new topics to the class, the students completing assignments individually, and teachers helping individuals.

The relatively high frequency of small group work appears to be a new trend (as reported by teachers in the previous section). In 1985, the authors reported "about 60 percent of teachers at all grade levels reported that they never had students work in small groups" (O'Shea & Robitaille, 1985). In 1990, over half of the teachers in Grade 7 said that students worked in small groups often or almost every day. In Grade 10, 43 percent of teachers said students worked in small groups.

Another significant trend appears to be the much greater use made of calculators, with over half the Grade 7 teachers reporting that students used calculators often or almost every day and 93 percent of Grade 10 teachers reporting the same information about their students. Teachers participating in the 1985 Assessment were asked questions about the use of calculators. At that time, the use of calculators was quite a controversial issue and many teachers expressed doubts about the value of students making use of calculators in class. It would appear from the data collected in this section, as well as in the following section on Mathematics in School where "learning to use calculators" was identified as important by teachers in Grades 7 and 10, that some of the negative attitude has abated.

Computers, on the other hand are still not used to any great extent. Over three-quarters of Grade 10 teachers said they rarely or never use computers in mathematics classes and almost half of the Grade 7 teachers reported the same thing. This matches the information provided in the 1985 assessment.

Students' reports differed somewhat from those of the teachers, but mostly in specific details, not in overall trends. In other words, the activities most teachers said mathematics classes usually would involve were the same ones which most students said classes usually would involve.

Mathematics in School

Grade 4

Teachers of Grade 4 mathematics thought the four topics they considered (operations on whole numbers, decimals, fractions, and estimation) were all very important for students to learn. They also thought they were relatively easy to teach and reported that they liked teaching those topics. The topic they thought of least importance of the the four was learning about fractions.

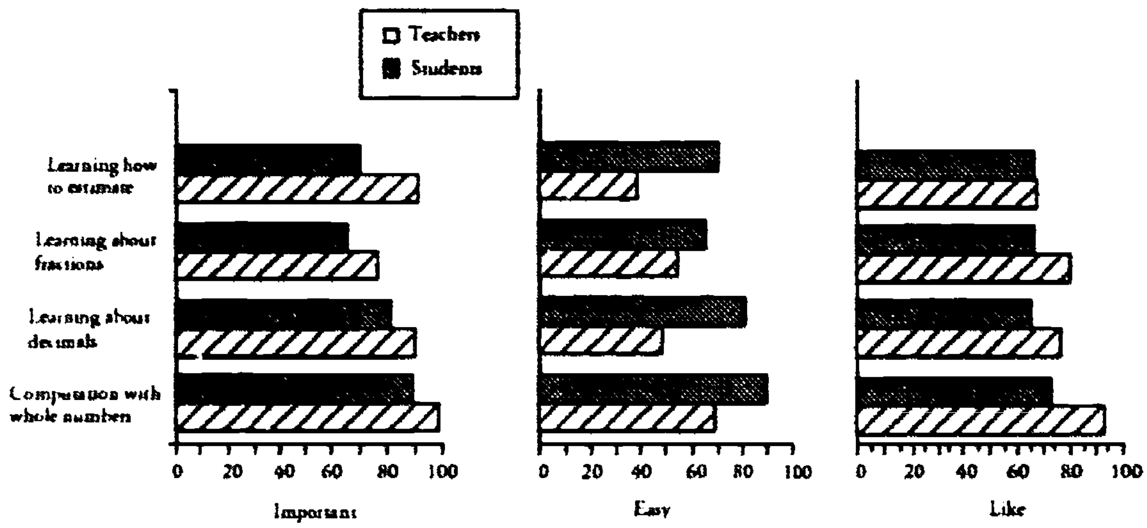
Teachers' reports in this section are very similar to those from the 1985

assessment. One exception is for reports on the importance of learning about decimal fractions. More teachers in 1990 (90 percent) thought decimals were important or very important than did so in 1985, when only 74 percent of teachers responded in these categories. The new curriculum has an emphasis on decimal fractions in earlier grades and the change in perception in this area is likely a result of that new emphasis.

The perception that learning about fractions is not as important as other topics appears to influence teaching practices. More than 50 percent of Grade 4 teachers report in the section which focused on students' opportunity to learn, that much of the information students required to answer questions about fractions had not yet been taught. The questionnaires were completed in mid-May of the school year.

Grade 4 students' opinions about mathematics topics were similar to those of the teachers, though students generally did not see topics to be as important as teachers did. They reported that all topics were relatively easy to learn and that they liked everything. They thought that using concrete objects to learn was the least important. Like their teachers, students thought fractions were less important than most other topics.

Figure 3-23. Mathematics in school responses in categories "very important" (easy, like) and "important" (easy, like): Grade 4.



Grade 7

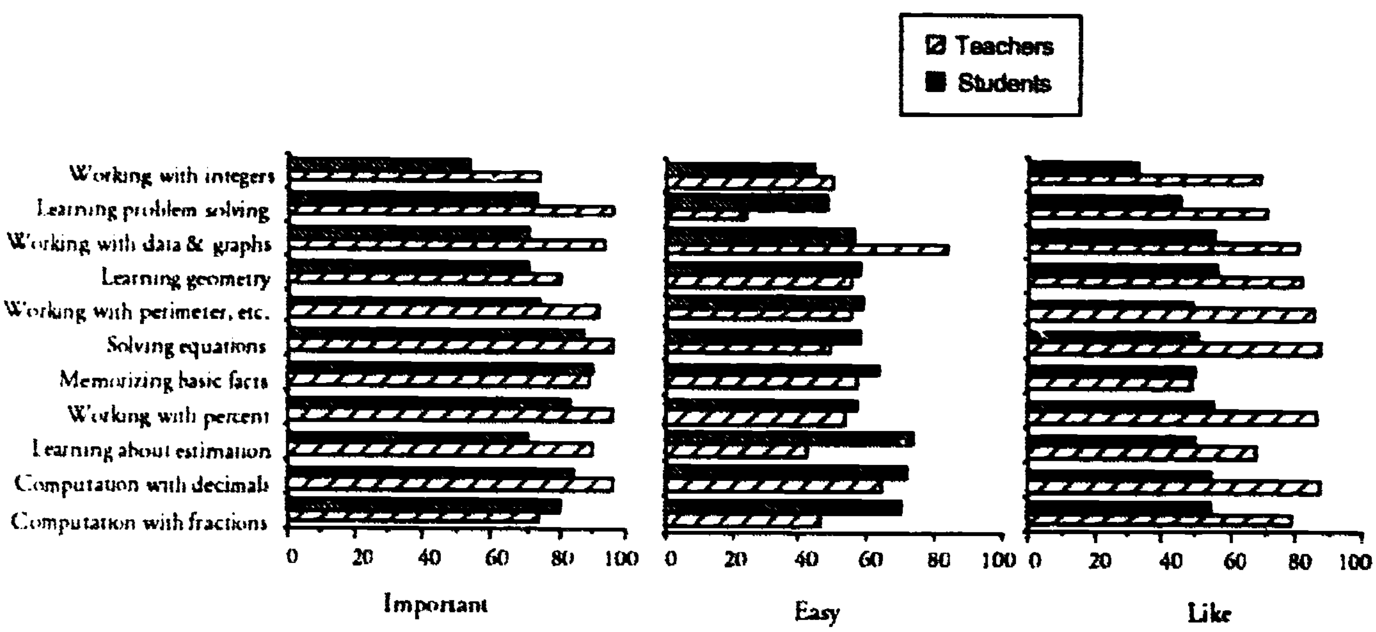
Grade 7 teachers thought learning to add, subtract, and multiply fractions (74 percent) and working with integers (74 percent) were the least important topics they were asked to consider. Again this perception is reflected in the Opportunity to Learn section where many teachers reported they had not taught the information required to do the items on integers. Working with integers is a new topic in the mathematics curriculum at Grade 7 which may, in part, explain teachers' perceptions. The topics most teachers identified as very important were decimals (97 percent), percents (96 percent), solving equations (96 percent), and problem-solving strategies (96 percent).

Grade 7 teachers thought most topics were relatively easy to teach. The area they reported as most difficult was teaching some strategies for problem solving, such as looking for patterns and making models. This topic was identified as difficult or very difficult by more than 60 percent of the teachers, whereas, other topics were identified as difficult by only about 30 percent or fewer teachers. The topic identified as easiest to teach was data and graphs, which only 4 percent of the teachers identified as difficult.

Teachers liked teaching most topics. They liked teaching basic facts the least (48 percent), followed by estimation (68 percent) and integers (69 percent). Topics they liked teaching most were decimals (87 percent), solving equations (87 percent), and percents (86 percent).

The reports of Grade 7 teachers in the 1985 assessment were virtually the same as those shown in Figure 3-24. The exceptions to this general observation are in the cases of geometry and measurement, where teachers in 1990 (30 percent) reported teaching those subjects was difficult or very difficult, compared to only 17 percent in 1985. In all other cases, the figures reported in each area in 1985 were within 5 percentage points of those for 1990. Many were identical. The new curriculum has not appeared to change, in any obvious ways, teachers' perceptions of mathematics.

Figure 3-24. Mathematics in school responses in categories "very important" (easy, like) and important (easy, like): Grade 7.



Students' perceptions were similar to teachers. They generally thought the various topics to be less important than teachers thought they were. They mostly thought topics were easier to learn than teachers thought they were to teach. For example, only 46 percent of teachers thought teaching fractions was easy, whereas 70 percent of students thought they were easy to learn. An exception to this general rule was in the case of data analysis, where 83 percent of teachers thought the topic was easy to teach, but only 56 percent of students thought it was easy to learn. Students generally liked topics less than teachers did.

Grade 10

Almost every Grade 10 teacher (99 percent) thought problem solving was an extremely important topic. Other topics they identified as important were solving equations (93 percent), decimals, fractions, and percents (89 percent), and geometry (88 percent). The topic most teachers thought was least important was data analysis (69 percent). Reports in the Opportunity to Learn section indicate that the information students require to respond correctly to some items in data analysis had not yet been taught.

Teachers reported that they thought most topics were not difficult to teach. The exception here is in the case of problem solving which was identified as difficult or extremely difficult to teach by 73 percent of teachers. The topic that fewest teachers found difficult to teach was measurement where only 13 percent of teachers said the topic was difficult or extremely difficult.

Grade 10 teachers generally like teaching most topics. Fewest enjoy teaching estimation (49 percent), data analysis (55 percent), and measurement (67 percent). The topics identified by most teachers as among those they like to teach were equations (89 percent), geometry (83 percent), and exponents (81 percent). These results are very similar to those from the 1985 assessment. The topics which were included in both assessments were ranked almost identically by teachers each time.

Students' reports were considerably different from teachers' results in Grade 10. They not only tended to see topics as less important, also, their conception of which topics were important differed from those of the teacher. For example, both teachers and students thought problem solving was the most important topic (99 percent of teachers and 73 percent of students), but 93 percent of teachers thought equations were important while only 56 percent of students thought so. Similarly, 85 percent of students thought decimals, fractions, and percents were important, and 64 percent thought estimation was important, making them first and third in rank order. Responses from teachers, on the other

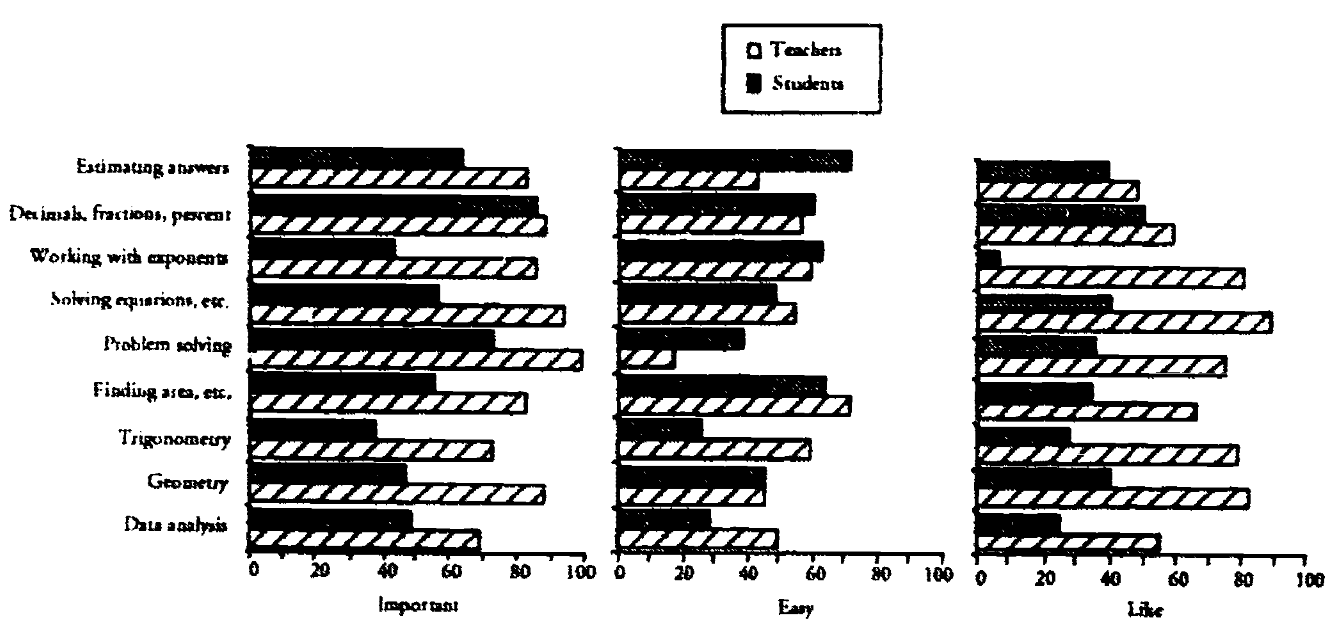


Figure 3-25. Mathematics in school responses in categories "very important" (easy, like) and important (easy, like): Grade 10.

hand, would place these at third and sixth. Students also rated data analysis higher than teachers did, though they agreed that trigonometry was of least importance.

Opportunity to Learn

Information about the opportunity, or lack of opportunity, students had to learn the mathematics necessary to answer correctly items in their test booklets is helpful for explaining student achievement in some cases. There is obviously a relationship between what students have had an opportunity to learn and what they actually know. The information also, though, provides an interesting picture of the curriculum as it is being implemented. For example, teachers answered the questionnaires in mid-May of the school year and yet in many cases there were significant areas of the curriculum which teachers reported had not yet been taught, and these cases often coincided with new areas of the curriculum or areas which teachers have reported elsewhere as less important than others.

Information about opportunity to learn provided in Tables C-1 to C-3 in Appendix C includes: a) the strand or topic represented by each of the items for which teachers provided information, b) the percent of teachers who thought between 61 to 100 percent of the students would get the item correct (without guessing), c) the percentage of teachers who said the information had not yet been taught, and d) the percentage of students who got the item correct.

Grade 4

Of the nineteen items where close to 50 percent or more of the teachers reported the mathematics required to answer the item correctly had not been taught either this year or in a previous year, eight had to do with fractions or decimal fractions, five with geometry, two with data analysis, two with place value, one with number operations, one with measurement, and one with general numeracy. The topic of fractions is one of the areas Grade 4 teachers reported they thought less important than others.

Since all of the items included in the questionnaire are based on intended learning outcomes of the curriculum to Grade 4, it is somewhat alarming to find that in late May, a significant number of teachers report that significant areas of the curriculum have not yet been taught. In some instances this is misinformation, since the mathematics required to answer the item had been taught in a previous year and the majority of students actually did answer the item correctly. This lack of information may be a function of the curriculum being relatively new. In many instances, however, it appears that teachers have simply not got around to teaching things they see to be less important or topics that are new to this curriculum. Teachers' reports about the excessive amount of material in the new curriculum may explain why some topics have not been taught by mid-May.

Not surprisingly, the items for which teachers reported they had not taught the mathematics required are also the items that most teachers thought most students would not be able to answer correctly. It turned out that in many cases teachers were not able to predict the success of their students accurately. For

example, only 8 percent of teachers thought students would get Item B25 on common fractions correct, and 78 percent of teachers said they had not yet taught the mathematics required to answer the item, yet 68 percent of students actually got the item correct. But, for item A14 on number operations, where 58 percent of teachers thought students would get the item correct and only 16 percent said they had not yet taught the required mathematics, only 21 percent of the students got it correct. Of the 26 items that fewer than 50 percent of the students were able to answer correctly, only 14 were also items that the fewest teachers predicted students would be able to answer. To put this information another way, more than half of the Grade 4 students were able to answer correctly many of the items teachers thought they would not be able to and were unable to answer many items that teachers thought they could.

It appears that if teachers have taught the material, they think students will have learned it. While it may be true that students do not learn things they have not had opportunity to learn, it is obviously not true that students necessarily learn what they have been taught. This may seem like a self-evident truth, but the results of this section of the questionnaire indicate it may not be so.

Grade 7

Grade 7 teachers often reported they had not yet taught students the mathematics required to answer items involving geometry, integers, and data analysis. There were twenty items identified by about 50 percent or more of the teachers for which the required mathematics had not been taught. Of these, eight dealt with geometry, six with integers, and six with data analysis. These three areas are the ones relatively new to, or being given renewed emphasis in, the curriculum. In some cases (e.g., Item D23 on data analysis), almost 90 percent of the teachers said they had not yet taught the required mathematics.

As was the case with Grade 4 teachers, there is a strong relationship between what teachers report they have taught and what they think students have learned, a relationship that is not always borne out by the results. Students were able to do well on some items for which teachers said the required mathematics had not been taught, yet they were unable in other cases to answer correctly items for which the mathematics had been taught.

Many teachers do not seem to be able to predict their students' achievement on individual items accurately. Of the 22 items which fewer than 50 percent of the students were able to answer correctly, only 9 of these were among the items that the fewest teachers predicted students would be able to answer. For Item A4 about expressions, for example, 47 percent of the teachers thought that between 61 to 100 percent of the students would be able to answer correctly. Eighty-seven percent of teachers said they had taught the required mathematics; however, only 12 percent of the students actually answered the item correctly. Students (56 percent) were able to answer Item D16 on integers correctly, yet only 32 percent of the teachers predicted that to be the case, and 57 percent said they had not yet taught the required material.

For one-third of the items included in teacher questionnaires, Grade 7

teachers reported the required mathematics had not yet been taught. Some teachers said the topic would be covered later in the year, some said it would be covered the following year, and others said it would not be taught for other reasons. As these questionnaires were administered in mid-May, and as the items were all taken from intended learning outcomes from the Grade 7 curriculum, this information gives cause for worry.

Grade 10

Four items that required knowledge of data analysis (probability) and geometry were those identified by the majority of Grade 10 teachers as the ones students would not be able to answer correctly. These were also the items for which teachers reported they had not yet taught the mathematics required. Of these four items, only two of them were actually problematic for the majority of students (only 20 percent got each correct). In the case of the other two items, 60 percent of the students (Mathematics 10 and Mathematics 10A students combined) answered the items correctly.

The data analysis items for which the required mathematics had not been taught were items aimed at both Mathematics 10 and Mathematics 10A students. The geometry items were both meant for Mathematics 10A students only. Generally, it appears that there are fewer areas where teachers have not yet taught the mathematics required for students to answer the items correctly than was the case for Grades 4 and 7.

Grade 10 teachers tend to see the same relationship between items taught and items students will answer correctly as was observed for Grades 4 and 7 teachers. In other words, Grade 10 teachers think that if they have taught the required mathematics, it is most likely that students will answer the question correctly. Again this was not always the actual case. For Item B5 on data analysis, for example, 76 percent of the teachers said that between 61 and 100 percent of the students would answer correctly, yet only 31 percent of the students were able to answer correctly. In fact, teachers generally thought more students would be able to answer items correctly than was the case. On the other hand, for Item A6/B6/C7/D7, only 17 percent of teachers said that most students would answer correctly, 58 percent of teachers said the required mathematics students had not been taught, yet 59 percent of the students answered correctly. Of the 14 items that fewer than 50 percent of the students were able to answer correctly, only five were among the items that the fewest teachers predicted students would be able to answer correctly.

Opportunity to Learn items have not previously been included on provincial assessments. It appears from the data collected through these items that they add a very useful dimension of information about the teaching of mathematics and the implementation of the curriculum. Subsequent chapters will refer to students' opportunity to learn as one aspect of explanations for student achievement. Subsequent assessments should continue to collect such information.

References

Fennema, E. (1981). The sex factor. In E. Fennema (Ed.) *Mathematics education research: Implications for the 80's.* Virginia: Association for Supervision and Curriculum Development.

Hembree, R. (1990).The nature, effects, and relief of mathematics anxiety. *Journal for Research in Mathematics Education, 21*(1), 33 - 46.

Isaacson, Z. (1989). Of course you could be an engineer, dear, but wouldn't you rather be a nurse or teacher or secretary? In P. Ernest (Ed.) *Mathematics teaching.* London: Falmer Press.

O'Shea, T. J. & Robitaille, D. F. (1985). Teachers of mathematics. In D. F. Robitaille and T. J. O'Shea (Eds.) *The 1985 British Columbia Mathematics Assessment: General Report.* Victoria: Queen's Printer.

Radwanski, G. (1987). *Ontario Study of the Relevance of Education, and the Issue of Dropouts.* Toronto: Ontario Ministry of Education.

Robitaille, D. F. & Garden, R. A. (1989). *The IEA Study of Mathematics II: Contexts and Outcomes of School Mathematics.* Oxford: Pergammon Press.

Robitaille, D. F. and Travers, K. J. (In press). International studies of achievement in mathematics. In D. Grouws (Ed.) *Handbook of Research on Mathematics Teaching and Learning.* New York: Macmillan.

Royal Society and the Institute of Mathematics and its Applications. (1986). *Girls and Mathematics.* London: The Royal Society.

University of British Columbia (1989). *The UBC Fact Book.* Vancouver: UBC.

Walberg, H. J. (1984). Improving the productivity of America's schools. *Educational Leadership, 42*(6), 19-27.

Chapter 4

Grade 4 Results

Thomas L. Schroeder

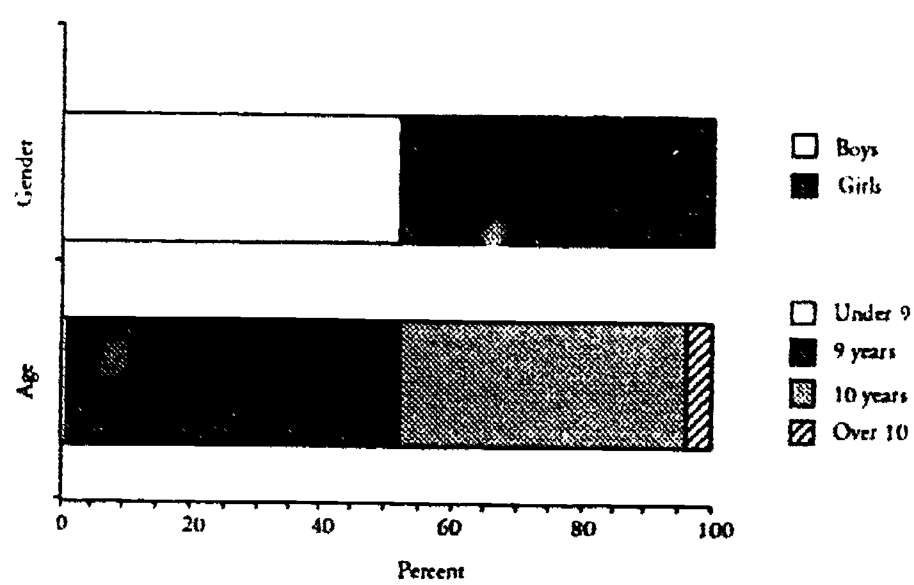
The results of the 1990 British Columbia Mathematics Assessment for Grade 4 are presented and discussed in this chapter. First, the student population is described and the assessment instruments are briefly discussed. Achievement results and Interpretation Panel observations are presented for each strand and topic. Student performance on items dealing with number sense and problem solving is described, and information on changes in achievement between 1985 and 1990 is presented. This is followed by a presentation of information concerning students' opportunity to learn mathematics and a description of information gained from scales dealing with students' attitudes towards mathematics and their reports of instructional practices in their mathematics classes. With this information, correlates of achievement are explored. Throughout the chapter, sample items have been cited in the discussion of findings, and the correct answer is indicated with an asterisk. All of the items are reproduced in an appendix. All percentages in the chapter have been rounded to the nearest whole percent.

Description of the Population

All students enrolled in Grade 4, except those identified by principals as unable to respond to a paper-and-pencil test, were required to complete one of the multiple-choice booklets. Only students designated as dependent handicapped, moderately mentally handicapped, severely handicapped, profoundly handicapped, or autistic were specifically excluded. Principals were instructed to ensure that all students in the English program, the Early French immersion program, and the *Programme-cadre de français* were included.

The majority of the Grade 4 students in the assessment were either 9 or 10 years old at the time that the assessment was conducted: 51 percent and 44 percent respectively. Less than one percent of the students reported ages under 9 years and approximately four percent reported ages over 10 years. The boys outnumbered the girls by 52 percent to 48 percent, an unexpectedly large difference. Figure 4-1 shows the age distribution of the population, and the proportions of girls and of boys.

Figure 4-1. Grade 4: Age and gender distributions.



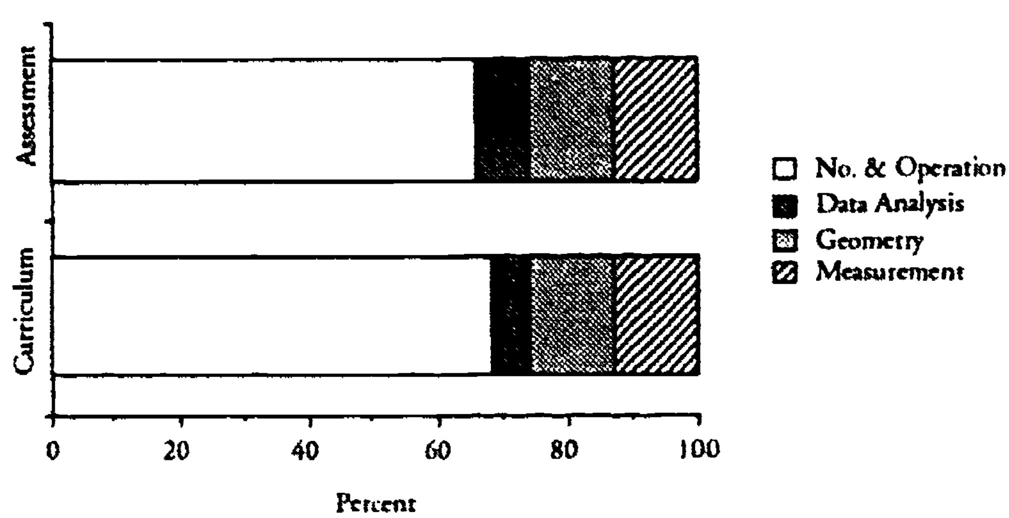
British Columbia offers three distinct programs of instruction in Grade 4: the regular Grade 4 program in English, Early French immersion, and *Programme-cadre de français*. Ninety-two percent of the students were enrolled in the English program, seven percent in Early French immersion, and one percent in *Programme-cadre de français*. Students for whom the language of mathematics instruction was English responded to assessment materials in English. Those for whom the language of mathematics instruction was French were provided with assessment booklets in French. Approximately five percent of the students responded to the booklets in French.

Instruments

As was reported in Chapter 2, 129 achievement items were contained in the Grade 4 student booklets. Of these 129 items, 126 were used to measure student achievement in four strands: Number and Operations, Data Analysis, Geometry, and Measurement. The strands were further divided into a total of 12 topics. Items were chosen to correspond to intended learning outcomes up to Grade 4 as listed in the *Mathematics 1-8 Curriculum Guide* published by the British Columbia Ministry of Education (1987). The remaining three items do not strictly match intended learning outcomes and were selected to test what has been termed "number sense". The nature of these items and the students' results on them will be discussed later in this chapter.

As Figure 4-2 shows, the percentage of items in each strand corresponds reasonably well to the estimated time allotment for that strand given in the Curriculum Guide (1987). Strands and topics which have relatively small time allocations were somewhat over-represented on the assessment tests, in order to ensure that a sufficiently large number of items would be available to make meaningful analyses of students' performance in these areas.

Figure 4-2. Curriculum time allotment and distribution of items by booklet for the assessment.



The 126 achievement items were distributed among four forms, A, B, C, and D, so that the estimated difficulties for each form were very nearly equal. Table D-1 in Appendix D shows the actual percentage correct overall and in each strand and topic for each of the four forms. Each booklet contained the same number of items from each strand, and the same number of items at each cognitive level. Of the 40 achievement items in each booklet, ten items, at least two

from each strand, were common to all forms. One of the three number sense items appeared on two forms (A and D). To examine changes over time in the achievement of Grade 4 students, 25 items which had appeared in the 1985 Assessment were included in the 1990 instruments. Table 4-1 gives details of the distribution of items across strands and topics.

Table 4-1. Distribution of achievement items across strands and topics.

	Number of Items			
Strand and Topic	Total[a]	Per Form[a]	Common[b]	Change[c]
Number & Operations	83	26	7	12
No. & Numeration	22	7	2	5
Number Operations	38	11	2	4
Decimals	13	4	1	2
Fractions	10	4	2	1
Data Analysis	9	3	1	2
Geometry	17	5	1	5
Lines, etc.	6	0-2	0	1
Solid Figures	6	1-3[d]	1	1
Rel'ns. & Transformations	5	0-3[d]	0	3
Measurement	17	5	1	6
Length	4	1	0	2
Area	4	1	0	1
Volume and Capacity	3	1-2[d]	1	1
Mass	3	0-1[d]	0	1
Time, Temp., Money	3	0-1[d]	0	1
Number sense	3	1	0[e]	0
TOTAL	126	40	10	25

Notes:
(a) Includes both items common to all four forms and items appearing on one form only.
(b) These items appeared on all four forms.
(c) These items also appeared on 1985 Assessment.
(d) In these topics the numbers of items per form varied over the range given.
(e) One number sense item appeared on two forms; the others appeared on one form only.

Each Grade 4 mathematics teacher completed one of three forms of a teacher questionnaire. This questionnaire contained, among other things, ques-

tions designed to gather information about students' opportunity to learn the mathematics necessary to answer achievement items correctly. Information gathered in this way is discussed in the strand and topic sections, including the discussion of individual items where appropriate.

Each student booklet contained four common background questions. Students were asked to report their sex, age, program (English, Early French immersion, or *Programme-cadre*) and language of mathematics instruction. The next three questions, also common to all four forms, sought information about students' beliefs and opinions regarding mathematics and jobs.

Students' attitudes towards topics in school mathematics were measured with 12 multi-part items distributed among the four booklets. These items asked the degree to which students felt that selected topics in school mathematics were important, easy, and likable. Forms A and B each contained four of these items, and the remaining four items were repeated on Forms C and D.

Nine questions were used to gather information about the frequency of various mathematics classroom practices during a typical school week. The practices surveyed included teacher demonstration using the blackboard or overhead projector, use of manipulative materials, assignment of individual seatwork, use of calculators, administration of quizzes and tests, review and discussion of homework, work in small groups, use of computers, and provision of help for individual students. Forms A and B each contained three of these questions, and the remaining three items were repeated on Forms C and D.

Achievement Results

The largest single component of the 1990 British Columbia Mathematics Assessment was the assessment of mathematics achievement. Virtually every student in Grade 4 spent up to 50 minutes responding to 40 achievement items. All items were in multiple-choice format with four suggested answers and a fifth alternative, "I don't know." The administration instructions to teachers directed them to inform students that, "Some questions will be easy, and others will be difficult. Read each question carefully, and answer it as well as you can." No directions were given as to the circumstances under which the "I don't know" option should be selected, nor were students advised whether or not they should guess at the answers to the items.

In the sections which follow, the performance of students is reported using two main statistics: percentage correct (both overall, and at the strand, topic, and item levels), and percentage selecting each response choice (at the item level). The percentage of students getting an item correct is known to be affected by a number of factors including the familiarity of the content and how recently it was taught, the style of the item, the complexity of the language used, the number of computational steps required, the nature and complexity of the problem-solving strategies needed, and the subtlety of the discriminations needed among answer alternatives. Within any given content area, items of quite different levels of difficulty can be constructed by varying the attributes listed above. The achievement items included in the assessment were selected on the basis of their range of difficulty levels, their ability to discriminate, and their curricular validity (whether they matched the general goals and specific intended learning outcomes

of the provincial curriculum). The percent selecting each response choice is considered important since it permits the identification of misconceptions and sources of error.

The Grade 4 Interpretation Panel examined all of the achievement items and then individually and as a group assigned to each item both the percentage of students they expected would get the item correct, and percentage of students they desired to get the item correct. The Panel then compared their "expected" and "desired" percentages to the actual percentage of students who answered each item correctly and commented on students' performance. In the following sections, the students' performance in each strand and topic is discussed. The overall percentage correct is reported, and selected items are used to illustrate the abilities of various proportions of the Grade 4 population. The observations and comments of the Interpretation Panel are also recorded.

Strand 1: Number and Operations

This strand is the most extensive one in the elementary mathematics curriculum, with 60 percent of the estimated time allotment in Grade 4 and about the same or slightly less in the other elementary grades. The assessment in this strand is based on 83 items, 26 appearing in each booklet. The strand has been subdivided into four topics: Number Concepts and Numeration, Whole Number Operations, Decimals, and Fractions.

The overall percentage correct was 52 percent for the strand as a whole, 57 percent in Number Concepts and Numeration, 55 percent in Whole Number Operations, 41 percent in Decimals, and 43 percent in Fractions. The students' actual percentage correct exceeded the Interpretation Panel's expected percentage correct on eight items, matched the expected percentage correct on 40 items, and was lower than the expected percentage correct on 35 items. The students' performance on six items reached the Interpretation Panel's desired level, but on the remaining 77 items it was lower.

Teachers' ratings of opportunity to learn for the 32 items in the Number and Operations strand that were included on the teacher questionnaires were moderately high. For the strand as a whole, an average of 68 percent of the teachers indicated that the content needed to answer the item had been taught in a previous year or earlier in the current year, 17 percent indicated that it would be taught later in the current year, and 13 percent indicated that it would be taught in a subsequent year or not at all. However, opportunity to learn ratings for items on decimals and fractions were noticeably lower than those for number concepts, numeration, and whole number operations.

Topics 1.1, 1.2, 1.3: Number Concepts and Numeration

Eleven percent of the estimated time in the Grade 4 curriculum is allotted to counting, place value, and theory of numbers. These topics and "early mathematical concepts" receive an even greater time allotment in Grades 1, 2, and 3. Twenty-two items measured achievement in these areas; seven items appeared in each booklet. The overall percentage correct in this topic was 57 percent. The students' actual percentage correct matched the Interpretation Panel's

expected percentage correct on 12 of the 22 items, it exceeded the Panel's expectations on two items, and it fell short on eight items. The students' actual performance on four items reached the Panel's desired level, but on the remaining 18 items the actual achievement was lower than the level desired by the Panel. Teachers' ratings of opportunity to learn in this topic were the highest of any strand or topic. An average of 86 percent of the teachers indicated that the content needed to answer the item correctly had already been taught in the current year or in a previous year.

Three items (A01, D01, and C02) were used to explore students' abilities with expanded notation: i.e. the practice of explicating the meanings of numerals by expressing them as sums of their components. Two of these items, A01 and D01, were answered correctly by nearly every student, but Item C02 was answered correctly by just over half of the students. It seems reasonable to attribute the small difference in percentage correct between items A01 and D01 to the fact that D01 includes a zero place holder and has its place values expressed in words. The larger difference between Item C02 and these two items may be due to the fact that it involves the ten thousands' place, which is introduced for the first

Item A01 2000 + 700 + 40 + 8 is the same as

	% of students	
A) 2748	92	*
B) 2784	2	
C) 7248	3	
D) 8472	1	
E) I don't know.	2	

Item D01 Which one of the following equals 5 thousands + 8 tens + 6 ones?

	% of students	
A) 5086	88	* (1985 - 85%)
B) 50086	4	
C) 50806	2	
D) 5000806	9	
E) I don't know.	2	

Item C02 30000 + 700 + 80 + 4 is the same as:

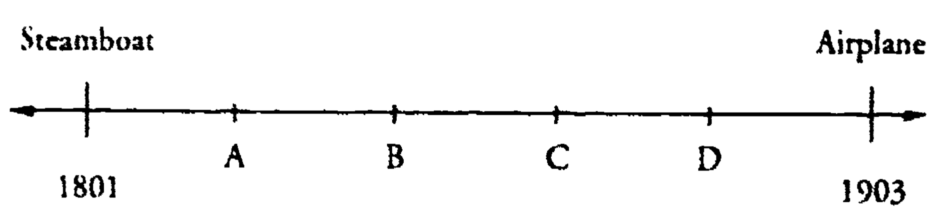
	% of students	
A) 3784	27	
B) 37084	8	
C) 307084	9	
D) 30784	54	*
E) I don't know.	2	

time in the curriculum for Grade 4. The other items which included numbers in the ten thousands (A03, B01, D02, and D03) were answered correctly by 48 to 66 percent of students.

Four items were concerned with rounding and estimating. Item C05 showed students a diagram of a piece of cloth containing 400 polka dots and asked them to estimate the number of polka dots on a similar-looking piece of cloth with about the same width and about half the length. Sixty-two percent of the students correctly estimated that it had between 100 and 250 dots. Item B03 asked students to round 1368 to the nearest hundred: 54 percent did so correctly. Item D05 showed a signpost giving the distances to three cities (328 km, 228 km, and 298 km) and asked students to choose which two were about the same distance away. Forty-six percent chose the correct answer, that the cities at 328 km and 298 km were about the same distance away. Only five percent thought that all three cities were about the same distance away, and six percent did not know. Item A08 (repeated on all four forms) required students to apply their rounding and estimating skills with three values, 1801, 1839, and 1903, in the context of a time line. Despite the complexity of this item, 45 percent of the students answered it correctly.

Item A08 The bicycle was invented about 1839. About where should 1839 be placed on this timeline?

Dates of Important Inventions



	% of students	
A) Point A	9	
B) Point B	45	*
C) Point C	26	
D) Point D	7	
E) I don't know.	11	

Item D04 tested students' ability to recognize different equivalent representations of numbers using manipulative materials (base-ten blocks). Students were asked to choose the diagram which did not contain blocks representing 2143 from among the following alternatives: one thousand, two hundreds, three tens, four ones; two thousands, one hundred, three tens, 13 ones; one thousand, 11 hundreds, three tens, 13 ones; and two thousands, 14 tens, three ones. Forty percent of the students chose the correct answer. The fact that the correct answer

was the first alternative probably decreased the difficulty of this item, but the fact that it was negatively worded and the fact that regrouping was required probably increased the difficulty.

The item in this topic area having the lowest percentage correct was Item A05, with 28 percent correct. The Interpretation Panel commented that the language used in this problem, "twice as many hundreds as ones," would be unusual and hence difficult for Grade 4 students. The percentage of students choosing "I don't know" was 24, which is rather high compared to other items in this strand and topic.

Item A05 Which one of these numbers has twice as many hundreds as ones?

	% of students	
A) 4318	8	
B) 8341	25	
C) 4831	13	
D) 3814	28	*
E) I don't know.	24	

Topic 1.4: Whole Number Operations

Thirty-three percent of estimated time in the Grade 4 curriculum is allocated to operations with whole numbers. Thirty-eight items measured achievement in this topic; 11 items appeared in each booklet. The overall percentage correct in this topic was 55 percent. The students' actual percentage correct matched the Interpretation Panel's expected percentage correct on 17 of the 38 items, it exceeded the Panel's expectations on three items, and it fell short on18 items. The students' actual performance reached the Panel's desired level on only one item: B14. On the remaining 37 items the actual achievement was lower than the level desired by the Panel. Teachers' ratings of opportunity to learn in this topic were high: second only to those in the Number Concepts and Numeration topic. An average of 76 percent of the teachers indicated that the content needed to answer the items correctly had already been taught in the current year or in a previous year.

Two items tested students' ability to carry out addition computations. Item A06 directed students to add 678 + 9 + 34 (presented in horizontal format), and Item D11 asked students to find the sum of 3163 and 9578 (presented in vertical format). Each of these items was answered correctly by about 80 percent of students.

Two items tested students' computational ability in subtraction (presented in vertical format). Both items involved regrouping (or "borrowing") across a zero. Item B11 (7000 - 86) was answered correctly by 68 percent of the students; Item C11 (5806 - 2438), by 62 percent. Another item, D16, directed students to round each number to the nearest 100 then estimate the difference 4736 - 2570 $\approx \boxed{}$. Only 26 percent chose the correct answer, 2100, but 15 percent chose 2200, the answer that one would get by subtracting first then rounding. This

item may test whether students can follow directions in order, rather than their ability to round or to subtract. A relatively large percentage of the students, 25 percent, chose "I don't know." This may indicate that they did not round and were confused by the fact that the answer they had computed was not among the alternatives presented.

Several items were used to explore students' abilities to recognize problem contexts in which addition and subtraction could be applied, but these problems were not computationally demanding. The percentage correct for these items ranged from 46 to 72 percent. On the easiest of these items, B14 with 72 percent correct, the correct answer could have been obtained simply by adding all numbers in the problem statement. Item C15 had a similar setting and similar values to manipulate, but it could not be answered correctly by applying a single operation to the data. Not surprisingly, its percentage correct was lower, 50 percent. This difference suggests that a sizable percentage of students, perhaps as many as 20 percent, may be adopting the strategy of isolating the numerical data and applying an operation without thinking through the meaning of the problem statement. However, on Item C15, only six percent of the students chose 27, the answer that is obtained by simply adding all three numbers given in the problem.

Item B14 John is 4 years older than Ellen, and Ellen is 5 years older than Monica. Monica is 12 years old. How old is John?

	% of students	
A) 10	15	
B) 3	5	
C) 1	3	
D) 21	72	*
E) I don't know.	5	

Item C15 John is 4 years older than Ellen, and Ellen is 11 years younger than Monica. Monica is 12 years old. How old is John?

	% of students	
A) 5	50	*
B) 27	6	
C) 15	36	
D) 19	3	
E) I don't know.	4	

Although students were not permitted to use calculators during the assessment, two items, A15 and B15, were given to investigate students' ability to solve problems involving addition and subtraction using calculators. On both of these items about three-fifths of the students answered correctly. A relatively large percentage of the students, 14 percent and 15 percent respectively, chose "I don't

know." In responding to the classroom processes questions, 56 percent of the students indicated that they "rarely" or "never" used calculators in their mathematics classes during a typical school week. Nonetheless, 67 percent of the teachers indicated that they had taught the content necessary to answer Item A15 correctly earlier in the current school year.

Item A15 Smith's department store wante[illegible] buy 4596 pairs of jeans from the factory. The factory had already made [illegible]798. How many more do they need to make for Smith's?

To solve this problem using a calculator, which buttons would you press?

		% of students	
A)	C 4 5 9 6 + 2 7 9 8 =	12	
B)	C 4 5 9 6 - 2 7 9 8 =	61	*
C)	C 4 5 9 6 ÷ 2 7 9 8 =	8	
D)	C 4 5 9 6 x 2 7 9 8 =	5	
E)	I don't know.	14	

Item B15 Valerie and David played a game of cards. At the end of the game, Valerie's score was 3146 and David's was 5725. What is the difference in their scores?

To solve this problem using a calculator, which buttons would you press?

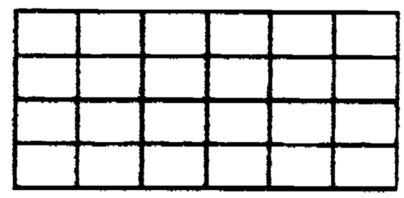
		% of students	
A)	C 3 1 4 6 + 5 7 2 5 =	8	
B)	C 5 7 2 5 + 3 1 4 6 =	9	
C)	C 5 7 2 5 - 3 1 4 6 =	59	*
D)	C 3 1 4 6 - 5 7 2 5 =	9	
E)	I don't know.	16	

Fundamental concepts and basic facts of multiplication were tested using four items. Item C08 asked students to identify a number that you would not say

when you count by sevens starting with zero; 77 percent correctly chose 34 as such a number. Items B09 and D08 involved relationships between number sentences and diagrams typically used when introducing concepts of multiplication. These items were answered correctly by 62 percent and 51 percent of the students, respectively.

Item B09 Which number sentence best describes this arrangement of rectangles?

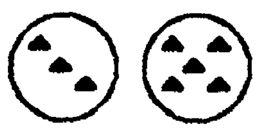
		% of students	
A)	1 x 24 = 24	10	
B)	2 x 12 = 24	6	
C)	3 x 8 = 24	5	
D)	4 x 6 = 24	62	*
E)	I don't know.	16	



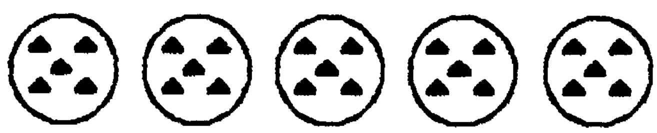
Item D08 Which picture illustrates the number sentence $3 \times 5 = 5 + 5 + 5$?

% of students

A)  51 *

B)  13

C)  10

D)  12

E) I don't know. 13

Multiplication computations with one or more multi-digit factors were included in several items. In Item D13, 74 percent of the students correctly multiplied 576 by 0 (presented in horizontal format). In Item B12, 71 percent of the students correctly found the product of 34 and 7 (presented in vertical format), and in Item D12, 58 percent of the students correctly multiplied 96 by 100 (presented in horizontal format). Reasoning about the relationship between multiplication and division sentences was explored in Item C09, which was answered correctly by 50 percent of the students.

Item C09	$50 \times 80 = 4000$, so _____.		
		% of students	
A)	$50 \div 80 = 4000$	13	
B)	$50 \div 4000 = 80$	17	
C)	$80 \div 4000 = 50$	9	
D)	$4000 \div 80 = 50$	50	*
E)	I don't know.	11	

The examples cited above indicate that students' rate of success with items involving multiplication was generally 50 percent or better. With division items, however, the percentage correct was generally 50 percent or less, but unlike the straightforward computations discussed above, most of the division examples were verbally presented and highly contextualized. Item C14 presented a situation in which the remainder was the relevant aspect; 51 percent of the student answered this item correctly.

Item C14 Brenda had 356 pennies. Before taking them to the bank, she put as many of them as she could into rolls. She put 50 pennies into each roll. How many pennies were not put into rolls?

		% of students	
A)	6	51	*
B)	7	13	
C)	306	23	
D)	406	4	
E)	I don't know.	8	

Item D15 involved a relatively familiar quotative division setting, but the fact that it included the numeral 4 in "Grade 4" may have caused some students' errors. Forty-one percent of the students found the correct answer, but the 27 percent of the students who gave the answer 60 probably fell into this trap.

Item D15 The Grade 4 class made 240 pieces of fudge for a candy sale. They packed 6 pieces in each bag. How many bags did they need?

		% of students	
A)	60	27	
B)	4	4	
C)	24	13	
D)	40	41	*
E)	I don't know.	15	

Item B16 is a difficult item because the context requires the quotient to be increased by one because of its remainder. Only 30 percent of the students answered this item correctly, but an additional 17 percent chose the answer that results from dividing correctly but ignoring the remainder.

Item B16 Each page in a scrapbook can hold 8 baseball cards. How many pages are needed to hold 60 baseball cards?

		% of students	
A)	7	17	
B)	52	20	
C)	8	30	*
D)	68	21	
E)	I don't know.	12	

Four items explored students' ability to identify certain vocabulary used in connection with multiplication and division. The terms tested and percentages correct were product, 55 percent correct on Item A10 and 41 percent correct on Item D09; divisor, 56 percent correct on Item B10; and remainder, 71 percent correct on Item A09. All of these items correspond quite closely to intended learning outcomes and limiting examples given in the curriculum guide (1987) for Grade 4, and all were classified as belonging to the knowledge level of cognitive demand. The students' levels of performance on all these items were substantially below the levels desired by the Interpretation Panel, and except for the term "remainder" were below the expected levels.

Topic 1.5: Decimals

Ten percent of the time in the Grade 4 curriculum is allocated to decimals; 13 items measured achievement in this topic; 4 items appeared in each booklet. The overall percentage correct for this topic was 41 percent. The students' actual percentage correct matched the Interpretation Panel's expectation on five of the 13 items; it exceeded the Panel's expectations on two items; and it fell short on six items. The students' actual performance reached the Panel's desired level on only one item. On the remaining 12 items the actual achievement was lower than the level desired by the Panel.

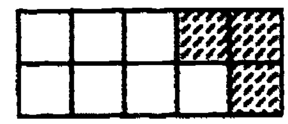
Analysis of the data on opportunity to learn obtained from the teacher questionnaires suggests that this topic had received less attention than most others. For the five items included on the teacher questionnaires, an average of only 44 percent of teachers had taught the mathematics needed to answer the item in a previous year or earlier this year; 53 percent of the teachers planned to teach it later in the year, in a subsequent year, or not at all.

The assessment in decimals included a number of items involving pictorial representations. Item B19, showing a rectangular region model for a decimal in tenths, was answered correctly by 61 percent of the students. This level of performance met the Interpretation Panel's expected level, but was below the desired

level.

Item B19 What fraction of the picture is shaded?

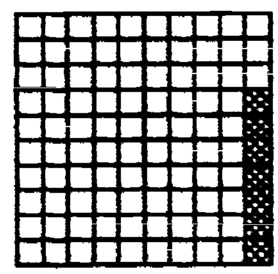
		% of students	
A)	0.03	12	
B)	0.3	61	*
C)	0.7	5	
D)	3.0	14	
E)	I don't know.	8	



Item A21 (repeated on all four forms) showed 0.07 represented on a ten-by-ten square array. Only 29 percent of the students selected the correct numeral for this model, although 46 percent of the teachers indicated that they had already taught the mathematics content needed to answer this item correctly.

Item A21 Which decimal fraction represents the shaded part of this figure?

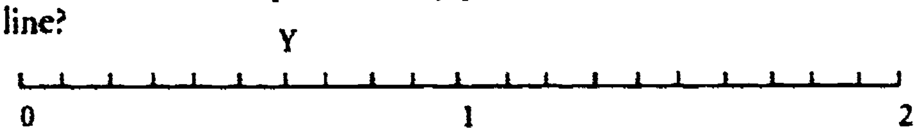
		% of students	
A)	7	16	
B)	0.07	29	*
C)	0.7	25	
D)	7.100	18	
E)	I don't know.	11	



Item B22 also involved square region models for decimals, but did not ask students to identify the value represented by the shaded region. Instead it asked them to select the model for a decimal between 0.25 and 0.65. Forty-four percent chose the correct answer, but 20 percent selected "I don't know."

In Item C22 a decimal in tenths was represented on a number line. This item proved to be the easiest one on decimals. Seventy percent of the students gave the correct answer even though only 52 percent of the teachers indicated that they had already taught the mathematics needed to answer it. Students' performance on this item exceeded the Interpretation Panel's expected level and reached the desired level.

Item C22 What number is represented by point Y on the number line?



		% of students	
A)	1.3	5	
B)	0.6	70	*
C)	0.3	5	
D)	0.06	10	
E)	I don't know.	8	

Three items required students to demonstrate their understanding of decimals expressed in words. Item A20 asked students to identify the numeral for "6 tenths." Although 44 percent selected the correct answer, 41 percent gave 6.0 as their answer. The place value of a digit in the hundredths' place was tested in Item C20. Only 22 percent of the students correctly identified the place value of the 9 in 0.29 as hundredths; 42 percent thought it was ones and 24 percent thought it was tenths. Item D20 required students to complete the statement "0.40 is the same as . . ." The correct answer "four tenths" was chosen by 49 percent of the students, but 34 percent chose "40 tenths."

Six items involved addition and subtraction with decimals. Item D22 presented an addition computation in vertical form with numbers in tenths only. Thirty-seven percent of the students gave the correct answer, but 44 percent of students gave a response that suggests that they have learned or invented an incorrect procedure for placing the decimal point in the answer.

Item D22 Add:

$$\begin{array}{r} 0.6 \\ 0.8 \\ \underline{+0.9} \end{array}$$

		% of students		
A)	0.023	4		
B)	0.23	44		
C)	2.3	37	*	(1985 - 19%)
D)	23	10		
E)	I don't know.	4		

Four items, B21, D23, A22, and A23, contained word problems involving subtraction of decimals having the same number of decimal places. The percentage correct for these items fell in a narrow band, from 44 to 48 percent. From 14 to 19 percent of the students chose the response "I don't know." Item A23 is typical of these items.

Item A23 Mrs. Smith had 94.10 m of ribbon in her florist shop. After completing all her orders, she had used 24.85 m of ribbon. How much ribbon did Mrs. Smith have left?

		% of students	
A)	69.25 m	46	*
B)	69.35 m	14	
C)	70.25 m	12	
D)	70.75 m	13	
E)	I don't know.	14	

A word problem involving addition of decimals with different numbers of decimal places (the so-called "ragged decimals" situation) was presented in Item C23. The correct answer was selected by 29 percent of the students, but 27 percent chose an answer that is obtained by failing to line up the decimal points of the addends. An answer that suggests an error was made in carrying from the

tenths to the ones was given by 26 percent of the students. The response "I don't know" was chosen by fewer students (only nine percent) than was the case for the subtraction word problems.

Item C23 In a relay race, Dan's time was 4.8 seconds, Gary's time was 5.3 seconds, and Jim's was 5.45 seconds. What was their total time?

		% of students	
A)	6.46 seconds	27	
B)	14.55 seconds	26	
C)	15.5 seconds	9	
D)	15.55 seconds	29	*
E)	I don't know.	9	

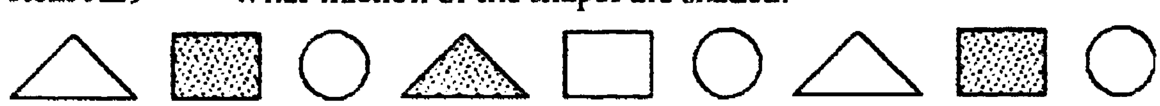
Topic 1.6: Fractions

Common fractions are allocated six percent of the time in the Grade 4 curriculum. Ten items measured achievement on this topic; four items appeared in each booklet. The overall percentage correct on this topic was 43 percent. The students' actual percentage correct matched the Interpretation Panel's expected percentage correct on six of the ten items, it exceeded the Panel's expectations on one item, and it fell short on three items. On all ten items the students' actual performance failed to reach the Panel's desired level.

Analysis of the data on opportunity to learn obtained from the teacher questionnaires suggests that, like decimals, fractions had also received less attention than most other topics. For the five items included on the teacher questionnaires, an average of 49 percent of teachers had taught the mathematics needed to answer the item in a previous year or earlier in the current year; 49 percent of the teachers planned to teach it later in the year, or in a subsequent year, or not at all.

As was the case for decimals, the assessment in fractions included a number of items involving pictorial representations. The curriculum guide specifies that students should work with fractions of regions and of sets and also recognize fractions as points on a line. Item A25, showing a fraction of a set of discrete objects, was answered correctly by 68 percent of the students. This level of performance reached the Interpretation Panel's expected level, but was below the desired level.

Item A25 What fraction of the shapes are shaded?



		% of students	
A)	3/6	10	
B)	2/3	6	
C)	3/9	68	*
D)	6/9	4	
E)	I don't know.	10	

Note: In the assessment booklets, fractions were printed in vertical format.

The region model for a fraction was tested in Item B24, which requires students to distinguish between models in which the shaded pieces are of unequal area and a model in which the pieces are of equal size. Although the ability to make this sort of discrimination is not explicitly mentioned in the curriculum guide, 76 percent of the teachers indicated that they had taught the mathematics content needed to respond correctly to this item earlier in the school year, and 70 percent of the students selected the correct alternative.

Item B24 Which one of the following pictures represents the fraction $1/3$?

		% of students	
A)		6	
B)		16	
C)		3	
D)		70	*
E)	I don't know.	4	

Item D27, containing a word problem involving a fraction of a set described in terms of its three subsets, was answered correctly by 46 percent of the students. Only 48 percent of the teachers indicated that they had taught the mathematics content needed to answer this question earlier in the year, 30 percent of the teachers indicated that they would do so later in the year, and 20 percent indicated that they would not teach the content in Grade 4.

Item D27 Tom has a collection of toy cars. He has 5 blue ones, 7 green ones, and 3 red ones. What fraction of his collection is green?

		% of students		
A)	7/10	14		Note:
B)	7/15	46	*	In the assessment
C)	7/8	23		booklets, fractions
D)	8/7	5		were printed in verti-
E)	I don't know.	9		cal format.

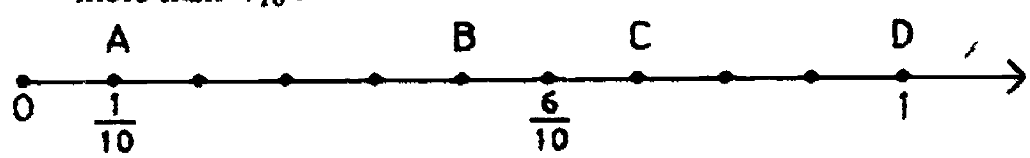
Another verbally presented problem requiring the co-ordination of multiple pieces of data was presented in Item C27. Although the fraction it includes, one-half, is likely to be familiar to Grade 4 students, one-half was used not in the context of a part that was one-half of a whole but in the less familiar context of one line being one-half as long as another. Forty-four percent of the students answered correctly.

Item C27 Three lines are related as follows:
Line X is twice as long as line Y.
Line Z is 1/2 as long as line Y.
Which line is the shortest?

		% of students	
A)	X	9	
B)	Y	20	
C)	Z	44	*
D)	X and Z are the same length	15	
E)	I don't know.	10	

Item A27 is another item in which the wording was relatively unusual and complex for students in Grade 4. In this item students were required to locate on a number line the fraction that is one-tenth more than six-tenths. As one member of the Interpretation Panel noted, a student might leave off reading the problem at the words one-tenth, and get the wrong answer. Apparently only a small number of students made this error, but the 20 percent who chose "I don't know" were probably confused by the expression "one-tenth more than."

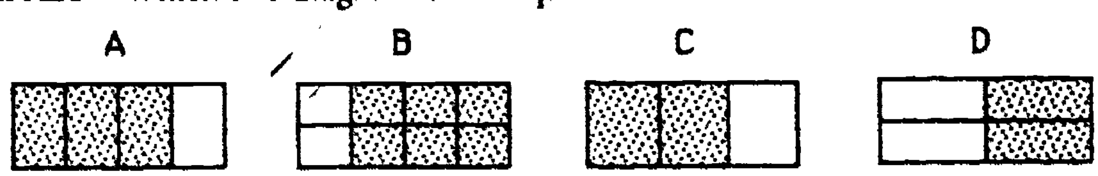
Item A27 Which letter on this number line represents the fraction that is $^{1}/_{10}$ more than $^{6}/_{10}$?



		% of students	
A)	A	8	
B)	B	19	
C)	C	37	*
D)	D	13	
E)	I don't know.	20	

Equivalence of fractions is a subtopic of major importance within the topic of common fractions in the Grade 4 curriculum. According to the curriculum guide, this concept is to be introduced using region models like those found in Item A26. Seventy percent of the teachers indicated that they had taught the

Item A26 Which two diagrams show equivalent fractions?

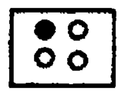
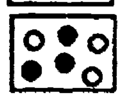
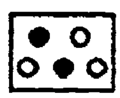


		% of students	
A)	A and B	42	*
B)	C and D	22	
C)	B and C	7	
D)	A and D	16	
E)	I don't know.	11	

mathematics content needed in this item earlier in the year, and 21 percent of the teachers indicated that they would do so later in the year, but only six percent indicated that they would not teach it. Forty-two percent of the students gave the correct response.

Item C25 contains, perhaps implicitly, another application of the notion of equivalence of fractions. In this item students are asked to identify the group that is one-half shaded, but the only correct answer alternative is a set in which three out of six are are shaded. Fifty-seven percent of the students answered correctly.

Item C25 Which one of the following groups of dots is one-half ($^1/_2$) shaded?

		% of students		
A)		10		
B)		57	*	(1985 - 64%)
C)		21		
D)		3		
E)	I don't know.	6		

A third application of the notion of equivalence is found in Item A24 which requires students to recognize the decimal expression for a common fraction in hundredths. Although this item corresponds precisely to an intended learning outcome and limiting example in the curriculum guide, only 42 percent of the teachers indicated that they had already taught this content during the current year or earlier, 38 percent indicated that they would do so later in the year, and 17 percent indicated that they would do so in a subsequent year or not at all. Thirty-four percent of the students answered this item correctly.

Item A24 $^{78}/_{100}$ is the same as

		% of students	
A)	78.0	28	
B)	7.8	6	
C)	0.78	34	*
D)	0.078	20	
E)	I don't know.	10	

Summary

The Number and Operations strand, with an allotment of about 60 percent of estimated time, is the most extensive one in the elementary mathematics curriculum. The strand has been subdivided into four topics: Number Concepts and Numeration, Whole Number Operations, Decimals, and Fractions.

The overall percentage correct was 52 percent for the strand as a whole, 57 percent in Number Concepts and Numeration, 55 percent in Whole Number Operations, 41 percent in Decimals, and 43 percent in Fractions. The students' actual percentage correct exceeded the Interpretation Panel's expected percentage correct on eight items, matched the expected percentage correct on 40 items, and was lower than the expected percentage correct on 35 items. The students' performance on six items reached the Interpretation Panel's desired level, but on the remaining 77 items it was lower. Although the percentages correct were higher on items in numeration and whole number operations and lower on items in decimals and fractions, the ratings by the Interpretation Panel are fairly consistent across the topics with the strand.

Teachers' ratings of opportunity to learn for the items in the Number and Operations strand were moderately high. For the strand as a whole, an average of 68 percent of the teachers indicated that the content needed to answer the items had been taught in a previous year or earlier in the current year, 17 percent indicated that it would be taught later in the current year, and 13 percent indicated that it would be taught in a subsequent year or not at all. Opportunity to learn ratings for items on decimals and fractions were noticeably lower than those for numeration and whole number operations.

The percentages correct for items in the Number Concepts and Numeration topic had a wide range, relatively high for items involving expanded notation, moderate for items involving representations with concrete materials, estimation, and rounding, and relatively low for items involving verbally presented, non-routine problems. The percentages correct for items involving whole number computations had a narrower range. In general, students did better with addition and subtraction than with multiplication and division, and better with straightforward computations than with verbally presented problems requiring analysis or interpretation of results. The percentages correct for items concerned with vocabulary related to multiplication and division were generally lower than expected.

The results in the topic of Decimals suggest that students are more familiar with tenths than with hundredths. Items exploring students' understanding of models, verbal representations, and decimal place value had a wide range of success rates, whereas the percentages correct on computational items and items requiring applications of computations with decimals had a narrower range. On items which required students to line up the decimal points or place the decimal point in the answer, some students demonstrated well-known misconceptions or defective algorithms.

In the topic of Fractions, students' performance was relatively strong on items involving pictorial representations and moderate on items with verbal presentations and those involving the concept of equivalence. One of the two lowest

percentages correct, 34 percent, was on an item in which students were required to identify the decimal representation of a fraction with a denominator of 100.

Strand 2: Data Analysis

The Data Analysis strand is the least extensive one in the elementary mathematics curriculum, but it is one that has been given increased prominence in the revised curriculum (1987). It receives 10 percent of the estimated time allotment in the curriculum for Grade 1, seven percent in Grade 2, and five percent in Grade 3 and Grade 4. Although the strand is not subdivided into topics, it does comprise a number of different areas including collecting and organizing data, constructing graphs and tables, and reading and interpreting graphs and tables.

The assessment in this strand is based on nine items, three appearing in each booklet. The overall percentage correct on this strand was 46 percent. The students' actual percentage correct matched the Interpretation Panel's expectation on four of the nine items, it exceeded the Panel's expectations on one item, and it fell short on four items. The students' actual performance exceeded the Panel's desired level on one item, and it reached the Panel's desired level on one item, but on the remaining seven items the students' actual achievement was lower than the level desired by the Panel.

Teachers' ratings of opportunity to learn for the six items in the Data Analysis strand that were included on the teacher questionnaires were somewhat lower than those for other strands and topics, and they differed a great deal from item to item within the strand. The percentage of teachers who had already taught the content needed to answer the items correctly varied from 38 to 73 percent. The percentage of teachers who responded that the content would be taught in a subsequent year or not at all ranged from six percent to 29 percent.

Three items tested skills related to collecting and organizing data. Item A28 required students to interpret a tally chart in which fives were represented by four vertical strokes connected by a fifth horizontal stroke. The percentage of students who answered this item correctly, 74 percent, was nearly the same as the percentage of teachers who indicated that they had already taught the content needed to answer the item in the current school year, 73 percent. On Item B27, 77 percent of the students showed that they were able to determine which cell in a two-way table contained a particular piece of data.

On Item A30 (repeated on all four forms) a set of data was presented and the collection of the data was described. Students were asked to identify what question could be answered using the information. Although 33 percent of the students answered the item correctly, 24 percent chose "I don't know." The Interpretation Panel commented that there was a great deal of reading to be done in this question, and also judged that the students' performance had reached the expected and desired levels. Only 51 percent of the teachers indicated that they had already taught the mathematics needed to answer the item; 18 percent of the teachers indicated that they would teach the content later in the current school year, and 29 percent indicated that it would not be taught in the current year.

Item A30 The list below shows the information Janice collected about the months in which the 27 students in her class had their birthdays. Which of the following questions can Janice answer using the information in this list?

July	Aug.	Sept.	Oct.	May	Feb.
June	Apr.	Dec.	Sept.	Mar.	Aug.
Oct.	June	Apr.	Dec.	Sept.	
June	Apr.	Dec.	Sept.	Nov.	
May	Feb.	Jan.	June	Jan.	

		% of students
A)	Who is the oldest student in her class?	15
B)	How many students are 10 years old?	10
C)	Who has a birthday in February?	13
D)	Were more students in Janice's class born in January or in June?	33 *
E)	I don't know.	24

Pictographs were included in two items. On Item C28 it was indicated that a given symbol represented 100, and students were asked to interpret three and a half symbols. The correct response, 350, was selected by 47 percent of the students, but 38 percent chose $3^1/_2$. Sixty-eight percent of the teachers indicated that the content needed to answer this question had been taught earlier in the current school year or in a previous school year.

Item A29 showed a set of data to be represented in a pictograph and asked students to choose a "reasonable" value for the pictograph symbol. Members of the Interpretation Panel believed that the term "reasonable" was ambiguous, and that the best answer to the question (five books per symbol, in their opinion) was not to be found among the answer alternatives. The responses of the teachers to the opportunity to learn question based on this item suggests that they also had concerns about the appropriateness of this item. Only 38 percent of the teachers indicated that they had already taught the mathematics needed to answer the item, 38 percent indicated that they would teach the content later in the current school year, and 22 percent indicated that it would not be taught in the current year.

Three items tested various skills related to the construction and interpretation of bar graphs. In Item D29 a set of data was presented in a simple table and students were asked to choose the bar graph that correctly represented it. This item was answered correctly by 65 percent of the students, a result which exceeded the expected percentage correct and the desired percentage correct set by the Interpretation Panel.

Item B28, which required students to determine the total of five values represented on a bar graph, was answered correctly by 38 percent of the students. The Interpretation Panel noted that this item was difficult because the graph lacked horizontal guide lines. Its vertical scale was marked every centimetre with

Item A29 Barbara is going to make a pictograph using the information shown below. She is going to use the book symbol to make her graph.

SYMBOL

BOOKS READ

Allen	40
Bev	15
Carl	20
Donna	35
Frank	60
George	15
Susan	65

A reasonable number of books for each symbol to represent is:

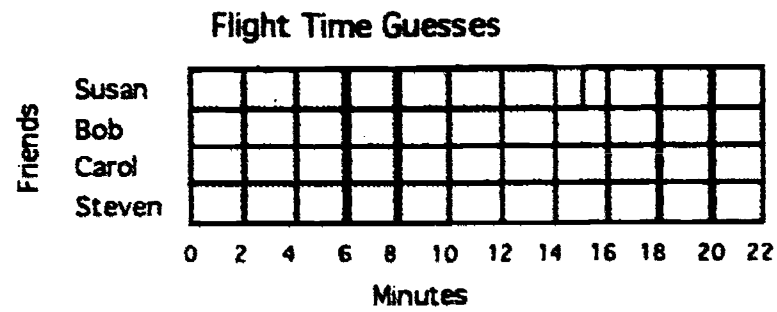
		% of students	
A)	1	9	
B)	10	25	*
C)	20	22	
D)	100	17	
E)	I don't know.	24	

values that differed by two units, so to determine the correct value for each bar one would need to judge to the nearest half centimetre. Suggested answers that were two less and two more than the correct total were selected by 10 percent and 22 percent of the students, respectively. Opportunity to learn results indicated that 68 percent of the teachers had already taught the mathematics needed for this item during the current school year.

In Item C29 students needed to interpret a bar graph and determine which bar represents a value closest to a given value, and 54 percent did so correctly. The Interpretation Panel commented that a substantial amount of reading is required by this item, but relatively few students, only five percent, chose "I don't know."

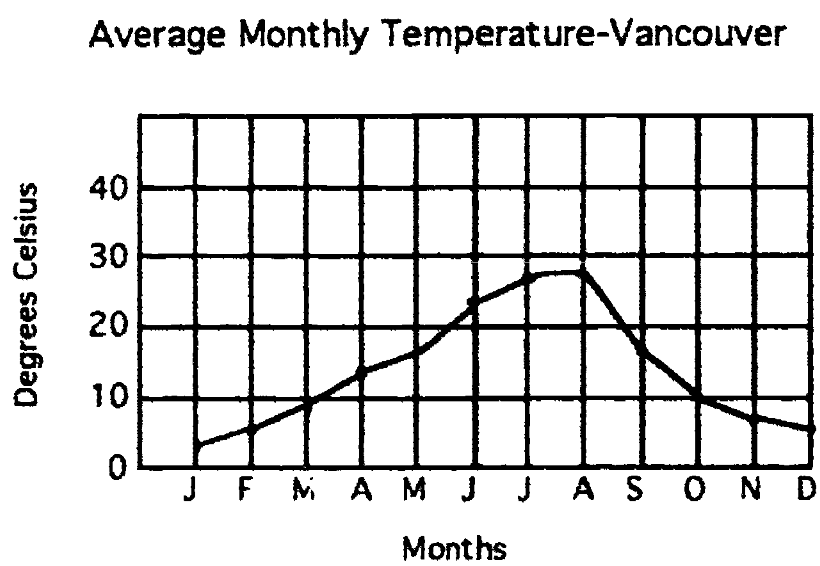
A broken line graph of average monthly temperatures was presented in Item D28 which is shown below, and students were required to identify the two months in which the average temperatures were the same. The Interpretation Panel commented that the graph was not drawn clearly and precisely, and felt that students would need to use a ruler to find the answer. The percentage correct for this item, 42 percent, was lower than the expected percentage correct and the desired percentage correct set by the Interpretation Panel. Teachers' responses to the opportunity to learn question indicated that 58 percent had already taught the content, 22 percent planned to do so later in the year, and 17 did not plan to do so.

Item C29 Pat was testing his model plane. His friends guessed how long it would stay in the air. The plane stayed up for 17 minutes. Who guessed closest to the correct time?



		% of students		
A)	Carol	54	*	(1985 - 60%)
B)	Susan	19		
C)	Bob	6		
D)	Steven	12		
E)	I don't know.	5		

Item D28 Which two months had the same average temperature?



		% of students	
A)	January and December	19	
B)	February and November	20	
C)	March and April	5	
D)	May and September	42	*
E)	I don't know.	11	

Strand 3: Geometry

Eleven percent of the time in the Grade 4 mathematics curriculum is allotted to geometry. This strand is comprised of several themes including linear concepts, plane figures, three-dimensional shapes, congruence (including transformations), symmetry, and co-ordinate graphing. For purposes of the assessment, the geometry strand has been subdivided into three topics: Lines, Plane Figures, and Coordinates; Solid Figures; and Relations and Transformations.

The assessment in the Geometry strand is based on 17 items, five appearing in each booklet. The overall percentage correct on this strand was 59 percent. The students' actual percentage correct matched the Interpretation Panel's expectation on three of the 17 items, it exceeded the Panel's expectations on nine items, and it fell short on five items. The students' actual performance exceeded the Panel's desired level on two items, and it reached the Panel's desired level on four items. But on the remaining 11 items the students' actual achievement was lower than the level desired by the Panel.

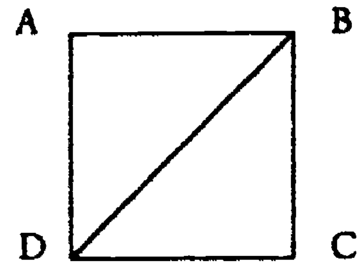
Analysis of the data on opportunity to learn obtained from the teacher questionnaires suggests that geometry had received somewhat less attention than most other strands, and that two of the three geometry topics (Lines, Plane Figures, and Coordinates; and Relations and Transformations) had received appreciably less attention. For the 11 geometry items included on the teacher questionnaires, an average of 57 percent of teachers had taught the mathematics needed to answer the item in a previous year or earlier in the current year; 39 percent of the teachers planned to teach it later in the year, in a subsequent year, or not at all. Detailed opportunity to learn data for each geometry topic are reported in the respective sections which follow.

Topic 3.1: Lines, Plane Figures, and Coordinates

There were six items for this topic; the number of items per booklet ranged from none to two. The overall percentage correct for this topic was 46 percent. The students' performance exceeded the Interpretation Panel's expectation on two items, but was lower than expected on four items. On all six items the actual level of performance was lower than the level desired by the Panel. Three items from this topic were included in opportunity to learn questions on the teacher questionnaires. Averaging over the three items, 46 percent of the teachers indicated that they had already taught the mathematics needed to answer the items, 23 percent indicated that they would teach the content later in the current school year, and 29 percent indicated that it would not be taught in the current year. However, there were dramatic differences in opportunity to learn among the three items, and those differences are discussed below.

Item D31 tested the convention of identifying line segments by the letters of their endpoints and the concept of the side of a square. Although 61 percent of the students responded correctly to this negatively worded question, 13 percent of students chose "I don't know."

Item D31 Which one of the following segments is not a side of the square?

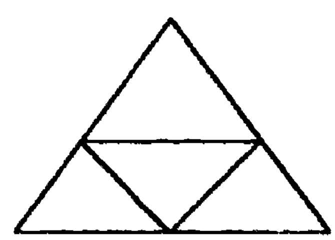


		% students		
A)	AB	8		
B)	BC	6		
C)	CD	7		
D)	BD	61	*	(1985 - 72%)
E)	I don't know.	13		

The situation presented in Item A34 was intended to assess whether students' concept of a triangle is sufficiently generalized to include "upside-down" triangles as well as ones in the more familiar "pointing-up" position, and whether students would notice the large composite triangle as well as the smaller ones of which it is formed. Presumably, the 39 percent of the students who chose the correct answer, 5, met both these criteria, whereas the 49 percent of students who chose 4 did not count either the centre triangle or the large outer one. Since only three percent chose 3, presumably because they counted only the three triangles in "standard" position, it seems likely that the largest triangle is the one that most students missed. Teachers' responses to the opportunity to learn question based on this item indicated that 69 percent had already taught the mathematics content needed to answer it.

Item A34 How many triangles are shown here?

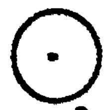
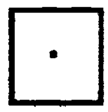
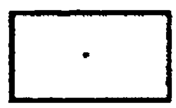
		% of students	
A)	4	49	
B)	5	39	*
C)	3	3	
D)	6	2	
E)	I don't know.	1	



Item B33 proved to be one of the most difficult items in the assessment. It was designed to test whether students would recognize a circle as the shape formed by points that are all the same distance from a fixed point. Only 18 percent chose the correct answer, and the largest percentage of the students, 42 percent, chose the rectangle which is less symmetrical than the square, which was

chosen by 14 percent. Fifteen percent of the students chose "I don't know." Members of the Interpretation Panel commented that some students might think the term "path" refers to something like a sidewalk, a figure composed only of straight lines, and might assume that a "path" could not be a circle. Only 33 percent of the teachers indicated that they had already taught the mathematics needed to answer Item B33; 16 percent of the teachers indicated that they would teach the content later in the current school year, and 48 percent indicated that it would be taught in a subsequent year or not at all.

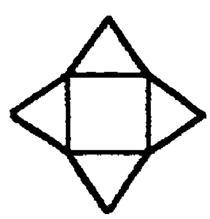
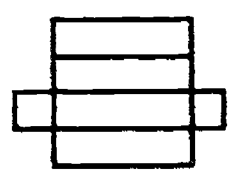
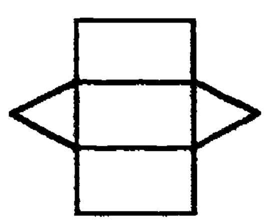
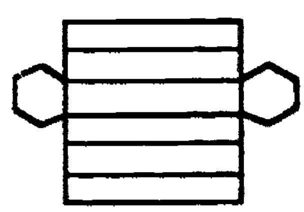
Item B33 A dog walks on a path that is always 5 m from a pole. Which of the following could be a drawing of the path?

		% of students	
A)		18	*
B)		6	
C)		14	
D)		42	
E)	I don't know.	15	

Two other items were concerned with relationships between solids and their nets. In Item B32 students were asked to identify the figure that could be cut out and folded to make a pyramid; 78 percent did so successfully, and 63 percent of the teachers indicated that this content had already been taught. Students were asked in Item C34 to identify the figure that could not be folded to make a cube; 53 percent answered correctly. Students' performance on both of these

---

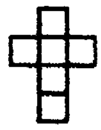
Item B32 Which of these figures can be cut out and folded to make a pyramid?

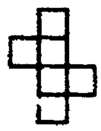
		% of students				% of students
A)		78	*	B)		3
C)		8		D)		3
E)	I don't know.	4				

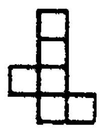
items surpassed both the expected and the desired levels set by the Interpretation Panel.

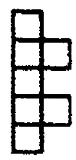
Item C34 Which one of these figures cannot be folded to make a cube?

% of students

A)  8

B)  13

C)  16

D)  53 *

E) I don't know. 6

Three items on coordinates were included in this topic. Item B30 showed a grid and a point labelled P, and asked for its coordinates. Thirty-five percent chose the correct ordered pair, but 41 percent chose the ordered pair with the elements reversed, and 11 percent chose "I don't know." As a result of an error in assembling the booklets, Item D33 had the same diagram as B30, but different suggested answers, answers that were intended to accompany a grid labelled in multiples of five rather than in ones. Fortunately, the correct response was included among the answer alternatives, but the distractors did not suit the figure. The correct answer was selected by 71 percent of the students; 12 percent chose "I don't know." Item A35 showed three points on a coordinate grid, gave their ordered pairs, and asked students to identify the two points farthest apart. The three points formed the vertices of an isosceles right triangle with the perpendicular sides along the grid lines. Forty-two percent of the students correctly chose the endpoints of the hypotenuse as the farthest apart; 12 percent "did not know." Opportunity to learn data collected for Item B30, the most straightforward coordinate graphing item, showed that only 36 percent of the teachers had already taught the topic, 35 percent planned to teach it later in the year, and 27 percent would not teach it in Grade 4. Coordinate graphing on grids labelled by ones, twos, fives, and tens is introduced in the curriculum in Grade 4.

Topic 3.2: Solid Figures

There were six items for this topic; the number of items per booklet

ranged from none to three. The overall percentage correct for this topic was 74 percent. Compared with the Interpretation Panel's expectations and desires, the level of performance on this topic was the highest of any topic in the entire Grade 4 assessment. The students' performance exceeded the Interpretation Panel's expectation on all six items; and, compared to the Panel's desired levels of achievement, the students' actual performance was lower on one item, approximately the same on three items, and higher on two items.

Teachers' ratings of opportunity to learn for items in this topic were relatively high and showed little variation from item to item. From 63 to 77 percent of the teachers indicated that the content needed to answer the items had already been taught during the current school year or in a previous school year.

Two items tested students' knowledge of names of solids. In Item A31, 85 percent of students correctly identified a cone from its sketch; 77 percent of the teachers indicated that this content had been taught during the current school year or previously. In Item C31, 68 percent of the students indicated that a soup can is shaped like a cylinder.

Ability to identify the faces and vertices of polyhedra was tested in two items. In Item A32, students were asked to identify which figure had six faces. The correct answer, a cube, was correctly selected by 81 percent of the students; 64 percent of the teachers indicated that this content had already been taught. A sketch of a triangular prism was presented in Item A33, and students were asked to indicate how many vertices it had; 41 percent did so correctly. Although 66 percent of the teachers indicated that this content had already been taught, 19 percent indicated that it would be taught later in the year, and 14 percent indicated that it would be taught in a subsequent year or not at all.

Topic 3.3: Relations and Transformations

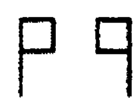
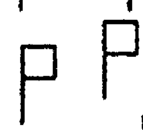
There were five items for this topic; the number of items per booklet ranged from none to three. The overall percentage correct for this topic was 50 percent. The students' actual percentage correct matched the Interpretation Panel's expectation on three items, it exceeded the Panel's expectations on one item, and it was lower on one item. The students' actual performance reached the Panel's desired level on one item, but on the remaining four items the students' actual achievement was lower than the level desired by the Panel. Teachers' ratings of opportunity to learn were relatively low for the items corresponding to this topic, and there was relatively little variation from item to item. Although all the items corresponded to intended learning outcomes in the Grade 4 curriculum, from 14 to 25 percent of the teachers indicated that the content needed to answer the item would not be taught in the current year.

In Item C36 students were told that figures that are the same size and shape are congruent and were asked to identify the congruent pair of figures; 67 percent selected the correct response. Although 53 percent of the teachers indicated that they had already taught the content needed to answer this question, 28 percent indicated that they would teach the content later in the year, and 16 percent indicated that the content would be taught in a subsequent year or not at all.

Three items dealt with aspects of transformational geometry. Item C33

asked students to identify the drawing that showed a figure and the result of sliding it. The correct response was chosen by 40 percent of students, but 24 percent chose a response involving a turn rather than a slide, and 14 percent chose "I don't know." Opportunity to learn results showed that 51 percent of teachers reported having already taught this content, 21 percent planned to do so later in the year, and 17 percent did not plan to teach it.

Item C33 Which one of these drawings was made by drawing a figure and then sliding it?

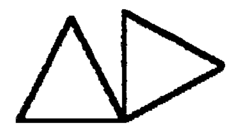
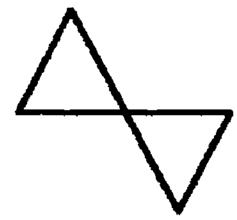
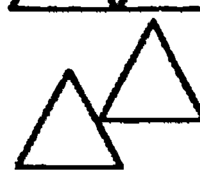
		% of students	
A)		24	
B)		12	
C)		40	*
D)		6	
E)	I don't know.	14	

In Item D36 students were asked to identify the drawing that showed a triangle and the result of turning it one-half turn. The correct response was selected by 37 percent of the students, but 29 percent chose a drawing in which the triangle was turned only one-quarter turn, and only five percent responded "I don't know." Teacher questionnaire results for this item showed that 48 percent of the teachers had already taught this content, 24 percent planned to do so later in the year, and 25 percent planned to do so in a subsequent year or not at all.

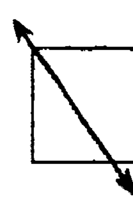
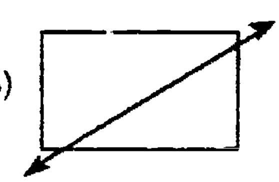
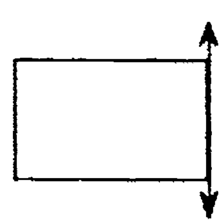
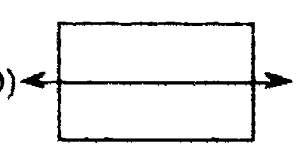
In Item B31 students were shown an equilateral triangle and a regular hexagon with sides of the same length. Students were asked how many pieces the same as the triangle were needed to cover the hexagon. The ability to relate figures in such a manner is relevant to the notion of tessellation, which is included in the Grade 4 mathematics curriculum but not tested in any other item in the assessment. Students might also be expected to use this process in developing the concept of area. Fifty-eight percent of the students answered this item correctly, a result that exceeded the expected level and matched the desired level set by the Interpretation Panel.

Identifying a line of symmetry in a rectangle was the content of Item D34. Sixty-one percent of the teachers indicated that this content had been taught earlier in the year or in a previous year; 67 percent of the students chose the correct response, but 13 percent chose "I don't know."

Item D36 Which of these drawings shows a triangle that has been turned one-half turn?

		% of students	
A)		29	
B)		37	*
C)		18	
D)		4	
E)	I don't know.	5	

Item D34 In which one of the following figures is the line a line of symmetry?

		% of students			% of students	
A)		5	B)		5	
C)		10	D)		61	* (1985 - 47%)
E)	I don't know.	13				

Strand 4: Measurement

Eleven percent of the estimated time in the Grade 4 curriculum is allotted to Measurement. The strand is divided into five topics· Lengtk · Area; Volume and Capacity; Mass; and T:me, Temperature, and Money. Seventeen items measured achievement in this strand, five items appeared in each booklet. The

overall percentage correct for the strand was 46 percent. The Interpretation Panel reported expected and desired percentages correct for 15 of the 17 items. The students' actual percentage correct matched the Interpretation Panel's expected percentage correct on nine items, it exceeded the Panel's expectations on one item, and it fell short on five items. On all 15 items the students' actual performance was lower than the level desired by the Panel. Teachers' average ratings of opportunity to learn for the eight measurement items included in the teacher questionnaires were nearly the same as the overall average for all strands and topics; 66 percent of the teachers indicated that the content had already been taught in the current year or in a previous year, 19 percent indicated it would be taught later in the current year, and 12 percent indicated that it would be taught in a subsequent year or not at all.

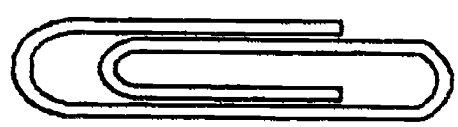
Topic 4.1: Length

There were four items for this topic, one item per booklet. The overall percentage correct for this topic was 54 percent. The students' actual percentage correct matched the Interpretation Panel's expectation on three items and was lower on one item. The students' actual performance was below the level desired by the Interpretation Panel on all four items. Teachers' ratings of opportunity to learn were relatively high for the two items from this topic that appeared on the teachers' questionnaires; 77 percent of the teachers indicated that they had already taught the content needed to answer the questions during the current school year, 16 percent indicated that they would teach it later in the year, and only five percent indicated that they would not teach it.

On Item B36 students were asked how many centimetres there are in one metre, and 64 percent answered correctly, but 15 percent thought the answer was 1000. On the opportunity to learn question for this item, 84 percent of the teachers indicated that this content had already been taught. Students were asked in Item A38 what unit should be used to measure the length of a fence around a vegetable garden. Sixty-nine percent of the students responded correctly, and 83 percent of the teachers indicated that this content had already been taught.

Item D38 tested students' ability to estimate length in millimetres by presenting them with a drawing of a familiar object and asking them to choose an approximation of its length. Although 48 percent of the students selected the cor-

Item D38 About how long is this jumbo paper clip?



		% of students	
A)	5 mm	27	
B)	50 mm	37	*
C)	100 mm	8	
D)	150 mm	6	
E)	I don't know.	13	

rect answer, 50 mm, 27 percent chose 5 mm, perhaps confusing millimetres with centimetres.

Item C39 contained a verbally presented problem involving the difference between two measurements, one given in metres, the other in centimetres. Students were told that Bella, a whale, could jump 627 cm high, and that Dana could jump 5 m high. The correct difference was found by 37 percent of the students, but 20 percent of the students apparently subtracted without regard to the units and gave the answer 622 cm. Thirteen percent responded "I don't know."

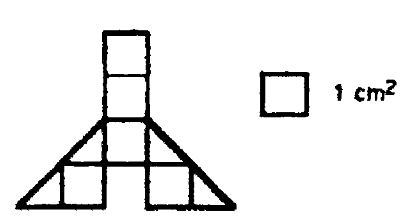
Topic 4.2: Area

There were four items for this topic, one item per booklet. The overall percentage correct for this topic was 38 percent, and the percentage correct on each item ranged from 36 to 39. The students' actual percentage correct matched the Interpretation Panel's expectation on two items and was lower on two items. The students' actual performance was below the level desired by the Interpretation Panel on all four items. Teachers' ratings of opportunity to learn were relatively low for the three items from this topic that appeared on the teachers' questionnaires; 55 percent of the teachers indicated that they had already taught the content needed to answer the questions during the current school year, 21 percent indicated that they would teach it later in the year, and 21 percent indicated that they would not teach it.

Students were asked in Item C35 the correct way to write "6 square metres." The correct response, 6 m^2, was selected by 39 percent of the students, and 33 percent chose "6 sq. mtrs." Teachers' responses to the opportunity to learn question based on this item indicated that 58 percent of the teachers had already taught this content, 18 planned to teach it later in the current year, and 21 percent planned not to teach it. Item B37 showed students a postage stamp and asked them to choose an expression for its area. The correct answer, "6 cm^2", was selected by 39 percent of the students, but 34 percent chose "6 cm", without the exponent. These results suggest that only about two-fifths of the students are familiar with the convention for writing metric units of area or are able to distinguish between length units and area units.

Determination of areas of figures drawn on grid paper by counting squares was included on two items. Item D39, which presented an irregular figure composed of squares and half squares, was answered correctly by 38 percent of the students, but 18 percent of the students selected the answer which corre-

Item D39 What is the area of this shape in square centimetres?



		% of students	
A)	7 cm^2	38 *	(1985 - 59%)
B)	12 cm^2	8	
C)	9 cm^2	14	
D)	5 cm^2	18	
E)	I don't know.	14	

sponds to the counting the number of full squares and ignoring the halves, and 14 percent of the students chose the answer which corresponds to the counting the total number of the full squares and the half squares. Fourteen percent of the students responded "I don't know."

In Item A39 students were asked to identify which two of three figures drawn on grid paper had the same area, a right triangle with both legs four units long, a two unit by four unit rectangle, and a right triangle with legs of two and six units. The correct response was given by 36 percent of the students, 21 percent responded that the two triangles had the same area, and 17 percent responded that each shape had a different area.

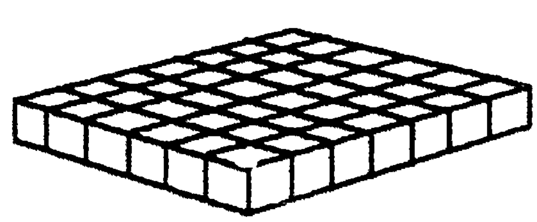
Teachers' responses to opportunity to learn questions based on items A39 and D39 show that only a little over half the teachers had already taught students how to find the area of a shape by counting squares. For Item A39, 52 percent of the teachers had already taught the content, 25 percent planned to do so later in the year, and 20 percent planned not to teach it in the current year. For Item D39, 54 percent of the teachers had already taught the content, 21 percent planned to do so later in the year, and 23 percent planned not to teach it.

Topic 4.3: Volume and Capacity

Three items tested content in this topic; each booklet contained one or two of the items. The overall percentage correct for this topic was 49 percent. The students' actual percentage correct reached the level expected by the Interpretation Panel on two of the items and was below it on one item. The students' actual performance was lower than the level desired by the Panel on all three items. Analysis of teachers' ratings of opportunity to learn for the two items from this topic showed that the percentage of teachers who had already taught the content needed to respond correctly to the items was near the average for all strands and topics, but a relatively large percentage of teachers, 23 percent, planned to teach the content later in the current school year and only a relatively small percentage, 11 percent, planned not to teach it.

One item, Item D35, dealt with finding the volume of a single-layer solid figure by counting cubes visible in a sketch of the figure. The correct answer was given by 59 percent of the students, but 14 percent gave a response indicating

Item D35 What is the volume of the figure?



		% of students	
A)	42 cubic units	59 *	(1985 - 82%)
B)	13 cubic units	5	/
C)	25 cubic units	5	
D)	55 cubic units	14	
E)	I don't know.	11	

that they had counted all the visible faces of the cubes, and 11 percent responded "I don't know." On the opportunity to learn questionnaire 55 percent of the teachers indicated that the content needed to answer this question correctly had already been taught, 26 percent indicated that it would be taught later in the current year, and 15 percent indicated that it would not be taught.

One of the two items on capacity, Item A36 repeated on all four forms, asked students to choose the unit that should be used to measure the capacity of a pop can. The correct response was given by 49 percent of the students, but 21 percent selected "cm". Seventy percent of the teachers indicated that they had already taught this content, and 21 percent indicated that they would do so later in the year. The second item on capacity, Item B39, appeared in Form B only. Despite the fact that this item gives the capacity of a pop can as 340 mL, students who responded to Form B performed no better on Item A36 than the students who did not have this clue. Item B39 required students to compute the number of millilitres of pop in a six-pack, and 44 did so correctly, but 10 percent responded that they did not know.

Topic 4.4: Mass

There were three items for this topic; three of the booklets contained one item each. The overall percentage correct for this topic was 41 percent, but the three items varied a great deal in difficulty. For one item, the students' actual percentage correct matched the Interpretation Panel's expected level, for one it exceeded the expected level, and for one it was lower, but the performance on all three items was below the Panel's desired level. None of the items in this topic was included in opportunity to learn questions administered to the teachers.

Item D37 asked students what unit they should use when they weigh an apple: 70 percent chose the correct answer, grams, and each of the incorrect answers, millimetres, centimetres, and millilitres, was selected by fewer than 10 percent of the students. In Item C38 students were asked to complete the statement, "A ten-year-old boy is likely to weigh". Although only 22 percent of the students chose the correct answer, 35 kg, 47 percent chose 75 kg, rather than one of the alternatives in grams. Members of the Interpretation Panel commented that students who had had experience at home weighing themselves in pounds may have been at a disadvantage in this item, since 75 pounds is a very reasonable answer.

A two-step word problem involving mass was presented in Item A40. In it students were told that a plate with six cookies on it weighed 312 g and that the plate weighed 72 g, and they were asked to find about how much one cookie weighed. Although 29 percent of the students found the correct answer, 38 percent chose 12 g, apparently dividing the mass of the plate by the number of cookies, and 10 percent responded "I don't know."

Topic 4.5: Time, Temperature, Money

There were three items for this topic, one item in each of three of the four booklets. The overall percentage correct for this topic was 47 percent, and the three items varied little in difficulty. Only one item was rated by the Interpre-

tation Panel as to expected and desired levels of achievement, and only one item was included in opportunity to learn analysis.

The item on time, Item C40, required the students to determine the number of minutes between 4:25 and 5:00. Fifty-four percent chose the correct answer, 35 minutes, but 26 percent chose 75 minutes, apparently subtracting the one time from the other as if they were ordinary base-ten numerals. This level of performance matched the Interpretation Panel's expected level but was lower than the desired level.

In Item A37 students were asked to select the most likely temperature for a sunny summer day; 44 percent chose the correct answer, 25° Celsius, 20 percent chose 55° Celsius, and 16 percent chose 85° Celsius. Responses to the teacher questionnaire item indicated that 66 percent of the teachers had taught this content earlier, and 18 percent planned to do so later in the current year.

A multiple-condition problem involving a number of coins and their value was presented in Item B38. Students were asked to identify a set of six coins with a value of 75 cents. Forty-three percent of the students selected the correct set, but 29 percent selected a set with the correct value but the wrong number of coins.

Strand 5: Number Sense

In addition to the achievement items organized into the curriculum strands, each Grade 4 booklet contained an item designed to assess students' "number sense" or "numeracy." Numeracy may be thought of as the ability to deal comfortably with fundamental notions of number, number operations, units of measurement, and chance. For a "numerate person" this degree of comfort extends beyond the ability to perform routine computations and have confidence in the accuracy of the results. The numerate person has an appreciation of the magnitudes of very large and very small numbers, can make reasonable estimations and approximations, and is able to check the reasonableness of results, particularly as they apply to situations involving very large or very small numbers.

Three number sense items appeared in the Grade 4 booklets. These items and one additional item were also included in the booklets for Grade 7 and Grade 10. Item A19 (also Item 19 on Form D) dealt with the concept of a million; students were asked to predict the height of a stack of one million pennies. Thirty-three percent of the students chose the incorrect answer 2 metres; 19 percent chose the correct answer, 2000 metres. Twelve percent chose the response "I don't know." Although Grade 4 students have been exposed informally to the concept of a million as a very large number, the scope of their curriculum in numeration is limited to numbers in the tens and hundreds of thousands.

Item B40 asked students to choose the approximate mass of a horse from among the alternatives 4 kg, 40 kg, 400 kg, and 4000 kg. Forty-six percent of the students chose the correct answer, 400 kg, and an additional 30 percent chose 4000 kg. Eight percent chose the response "I don't know." This item was easier for the students than Item C33, included in the Measurement strand, which asked them to choose the approximate mass of a ten-year-old boy from among the alternatives 35 g, 75 g, 35 kg, and 75 kg. Although only 22 percent of the

students answered that item correctly, 69 percent chose one of the two alternatives in kilograms rather than an alternative in grams. The Interpretation Panel commented that the students who chose 75 kg (47 percent), may have based their answer upon experiences weighing themselves in pounds; 75 pounds is a very reasonable answer for this question, but 75 kilograms is not.

Item C19 asked students about the result of dividing a number other than zero by a number greater than two. Twenty-one percent of the students chose the correct response, that the answer would be less than half the original number. Twenty-four percent of the students thought that the answer would be more than half the original number. Sixteen percent of the students thought that the answer would be impossible to predict.

Opportunity to learn ratings for the number sense items were lower than for the items related to the curriculum strands. Although the rating for Item B40 was similar to the ratings for items in area and volume, the ratings for other two number sense items were noticeably lower. For Item B40, estimating the mass of a horse, 60 percent of the teachers indicated that the content had already been taught in the current year or a previous year, 20 percent indicated it would be taught later in the current year, and 19 percent indicated it would be taught in a subsequent year or not at all. For Item A19/D19, estimating the height of a stack of one million pennies, 29 percent of the teachers indicated that the content had already been taught in the current year or a previous year, 16 percent indicated it would be taught later in the current year, and 52 percent indicated it would be taught in a subsequent year or not at all. For Item C19, dividing by a number greater than two, 22 percent of the teachers indicated that the content had already been taught in the current year or a previous year, 13 percent indicated it would be taught later in the current year, and 62 percent indicated it would be taught in a subsequent year or not at all.

The results of the numeracy items indicate that students in Grade 4 do not have a good sense of very large numbers, but that in situations that are closer to their experience, such as the mass of a horse, some students can make reasonable approximations. Most Grade 4 students' understanding of division does not seem well enough developed to enable them to reason that since dividing by two gives half the number, dividing by a number greater than two should give a result that is less than half the original number. The Interpretation Panel voiced concerns about the appropriateness for students in Grade 4 of the number sense items provided, and suggested that additional and more appropriate items be developed. Because the items were judged to be inappropriate, the students' level of performance was rated as above the expected level and at the desired level. The Panel also recommended that teachers teach more about the concepts of large numbers.

Problem Solving

The Mathematics Curriculum Guide for Grades 1 to 7 (1987) includes a curriculum strand entitled Problem-Solving Skills which is allocated 13 percent of the estimated time in Grade 4. The intended learning outcomes of this strand include skills and abilities such as: demonstrating understanding of problems; clarifying problems; estimating solutions; determining the reasonableness of data,

estimates, and solutions; and solving a variety of types of problems including application problems, puzzle problems, and open-ended problems. Problem-solving plans and strategies specifically mentioned in the curriculum up to Grade 4 include acting out a problem, drawing a diagram or making a model, looking for a pattern, using guesses and checks, writing and solving a number sentence, classifying and ordering information, and making lists, tables, or graphs. In addition to the intended learning outcomes in the Problem-Solving Skills strand, intended learning outcomes in problem solving are also found in the content strands as well. Although the curriculum for Grades 1 to 7 includes problem-solving skills as a curriculum strand, the revised mathematics curriculum guide for Grades 8 to 12 (1988) does not. In the secondary grades the curriculum guide indicates that problem-solving activities are to be integrated into the content strands of the curriculum. For purposes of the Assessment, problem-solving items have been included in the content strands rather than being assigned to a separate problem-solving strand.

One of the following three cognitive levels, Knowledge (K), Comprehension (C), or Application/Problem Solving (APS), was assigned to each of the 126 achievement items. In each booklet 40 percent of the items in each strand were at the APS cognitive level. Some of these items involve relatively straightforward applications of mathematical skills in realistic settings; such items have sometimes been referred to as "translation" problems since they require the ability to translate a word problem into appropriate mathematical symbols and the ability to carry out a single familiar mathematical operation. Others of these items involve more than one step, but entail only routine applications of familiar operations. Other APS items could be described as non-routine problems. For these items it is unlikely that a standard procedure or algorithm would present itself. Instead, the student would need to use a general problem-solving strategy or heuristic such as: making a model or diagram; looking for patterns; making a table, list, or graph; or working backward. Examples of single-step, multi-step, and non-routine problems are given in this section, and students' performance on them is discussed along with information on opportunity to learn and Interpretation Panel ratings and comments, as appropriate.

Examples of single-step translation problems are found in items D14, C40, A18, B39, and B16. These items involve fairly routine applications of subtraction, multiplication, or division. The percentage of students who answered each item correctly ranged from 30 percent to 65 percent, with three of the five items within five percent of 50 percent. About 10 percent or fewer chose "I don't know." Teachers' ratings of opportunity to learn for these items were relatively high; in the range of 70 to 90 percent of the teachers indicated that the content needed had already been taught. The Interpretation Panel rated the students' actual performance as below the desired level for all of these items, but at the expected level for most of them.

Item D14 presented a missing addend situation which can be solved in a routine way by subtracting the numbers given in the problem. Apparently 65 percent of the students did so correctly, an additional 17 percent may have made a computational error in their attempt to subtract, and 13 percent of the students chose answers that are unreasonable and suggest that they added or attempted to add the numbers given.

Item D14 Dan had 125 hockey cards. At recess, he got some more. When he counted the cards at lunch he had 180. How many did he get at recess?

		% of students	
A)	305	9	
B)	65	17	
C)	55	65	*
D)	205	4	
E)	I don't know.	5	

In Item A18 students were presented with an application of multiplication and asked to choose an appropriate estimate for the answer. The only reasonable answer, 660, was selected by 46 percent of the students, but 20 percent of the students chose an unreasonable answer that they apparently obtained by adding the data given.

Item A18 Schools have one teacher for every 22 students. Gatewood School has 33 teachers. Which of the following is the best estimate of the number of students attending Gatewood School?

		% of students	
A)	55	20	
B)	660	46	*
C)	3300	14	
D)	6600	8	
E)	I don't know.	12	

Item B39, which asked students to compute the number of millilitres of pop in a six-pack, given the number of millilitres in a single can, was discussed in an earlier section. This routine application of multiplication was successfully handled by 44 percent of students. The fact that one of the two essential pieces of data was presented in words ("a six-pack") rather than as a numeral, may have reduced the percentage correct on this item. Item C40, also discussed in an earlier section, required the students to determine the number of minutes between 4:25 and 5:00. The correct answer, selected by 54 percent of the students, might have been found by subtracting 25 minutes from the 60 minutes in an hour or by some other method such as noting that five minutes more would make "half past" and 30 minutes more would complete the hour. However, 26 percent of students apparently attempted to subtract 425 from 500, treating the data as ordinary base ten numerals rather than numbers of hours and minutes, and getting 75 minutes as their result.

The translation problem with the lowest percentage correct was Item B16, an application of division that requires that the quotient be increased by one because there is a remainder Only 30 percent of students gave the correct answer, but 17 percent gave an answer that could have been found by dividing

and ignoring the remainder, 21 percent chose the sum of the two numbers given in the problem, and 20 percent chose their difference. These facts suggest that a majority of the students applied computational processes blindly, without reflecting on the meaning of the situation and the reasonableness of their work.

Item B16 Each page in a scrapbook can hold 8 baseball cards. How many pages are needed to hold 60 baseball cards?

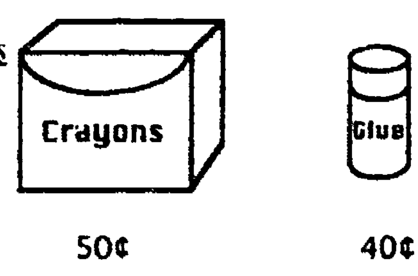
		% of students	
A)	7	17	
B)	52	20	
C)	8	30	*
D)	68	21	
E)	I don't know.	12	

Multiple-step and multiple-condition problems are found in items A17, D18, B38, C18, and A40. None of these problems was presented to teachers for opportunity to learn analysis, and two of them were not rated by the Interpretation Panel as to expected and desired levels of achievement. The percentages correct ranged from 57 percent to 29 percent, results that were mainly at the expected levels and consistently below desired levels.

Item A17 uses verbal and pictorial forms to present a situation with multiple conditions in which a number of different operations could be applied. For example, students might begin with the total sum and repeatedly subtract from it the prices of boxes of crayons and sticks of glue, or multiplication could be used to find the total cost of crayons followed by subtraction and even division. By one means or another, 57 percent of the students found the correct answer. Teachers' ratings of opportunity to learn showed that 85 percent had already taught the content needed to answer this question and an additional seven percent planned to do so later in the year.

Item A17 The prices for crayons and for glue are shown below. Katie has $2.50. If she buys 3 boxes of crayons, what is the greatest number of sticks of glue she can buy with the rest of her money?

		% of students	
A)	6	7	
B)	2	57	*
C)	3	17	
D)	5	9	
E)	I don't know.	9	



In Item D18 students were presented with a situation in which several additions or subtractions were needed, and in which data are presented in tabular form. Students might have added each player's scores and then found the difference between the two totals; or, since the scores for each round were easy to work

with, might have kept track of who was ahead and by how much from round to round. The correct answer was found by 46 percent of the students, a result that was below the Interpretation Panel's expectation.

Item D18 Kyle and Bob are playing a game. The object of the game is to get the highest point total. This chart shows how many points they each scored in the first four rounds. Who is ahead and by how many points?

SCORE CARD		
Player	Kyle	Bob
Round 1	125	100
Round 2	125	125
Round 3	150	100
Round 4	50	150
Round 5		
Total		

		% of students	
A)	Kyle is ahead by 175 points.	10	
B)	Bob is ahead by 100 points.	21	
C)	Kyle is ahead by 25 points.	13	
D)	Bob is ahead by 25 points.	46	*
E)	I don't know.	9	

Item C18, another item with multiple conditions, is most efficiently attacked with the strategy of working backward, that is, evaluating each suggested answer and choosing the one that fits the data. To do this most efficiently, multiplication should be applied in finding the total number of wheels for each type of vehicle, but repeated addition could also be used. Only 35 percent of the students found the correct answer, and a relatively large percentage, 23 percent, chose "I don't know."

Item C18 I counted 44 wheels on the vehicles in the parking lot at the Fairbanks golf course. The only vehicles in the parking lot were cars with 4 wheels and golf carts with 3 wheels. How many golf carts and how many cars could have been parked there?

		% of students	
A)	10 golf carts and 2 cars	11	
B)	2 golf carts and 10 cars	15	
C)	6 golf carts and 6 cars	15	
D)	4 golf carts and 8 cars	35	*
E)	I don't know.	23	

Two items, each briefly discussed in an earlier section, involve multiple steps and measurement contexts. In Item B38 students were asked to identify the set of six coins with a total value of 75 cents. The correct response was selected by 43 percent of the students, but 29 percent chose a set with the correct value but the wrong number of coins, apparently disregarding one of the conditions. Item A40 presented a two-step word problem involving mass. In it students were told that a plate with six cookies on it weighed 312 g and that the plate weighed 72 g, and they were asked to determine about how much one cookie weighed. Only 29 percent of the students found the correct answer. However, 38 percent chose 12 g, apparently dividing the mass of the plate by the number of cookies, that is performing operations on data without regard to their meaning.

Four examples of non-routine problems are found in items A07, B18, B25, and A14. In these items the Contract Team members expected that students would understand the problem and recognize the possibility of a solution, but would not have a standard procedure or algorithm to solve it. Therefore students would have to use a general problem-solving strategy such as looking for a pattern or making a table or organized list.

Item A07 Fill in the squares by continuing the patterns horizontally and vertically. What number belongs in $\boxed{X}$?

60	63	66	
55	58	61	
50	53	56	
			X

		% of students	
A)	69	12	
B)	45	8	
C)	54	51	*
D)	59	8	
E)	I don't know.	20	

The percentage of students who answered each of these items correctly was relatively low, ranging from 51 percent to 22 percent. The Interpretation Panel judged these results to be below the expected level on one item, at the expected level on the other three and below the desired level on all four items. Teachers' ratings of opportunity to learn had a wide range; from 82 percent to 23 percent of teachers indicated that they had already taught the content required. From 11 percent to 42 percent indicated that the content would not be taught in the current school year.

Item A07, which directed students to find and continue two patterns, was answered correctly by 51 percent of students, but a relatively large number,

20 percent, chose "I don't know." In responding to the opportunity to learn question on this item, 68 percent of teachers indicated that they had already taught the required content, 11 percent indicated that they would teach it later in the year, and 18 percent indicated that it would be taught in a subsequent school year or not at all.

Item B18 On the first day Joe read one page of a book, on the second day he read 2 pages, on the third day he read 4 pages, and on the fourth day he read 7 pages. If Joe continued to read the book following this pattern, how many pages did he read on the sixth day?

		% of students	
A)	32	9	
B)	31	9	
C)	13	34	
D)	16	34	*
E)	I don't know.	13	

Item B18 also required students to detect and extend a pattern, but the pattern is a more complicated one, and students were required to find the second term after the end of the given sequence. These factors suggest that making a table like the one below would be very helpful, if not absolutely necessary. An extension to the table containing the differences between the numbers of pages read on successive days would be even more helpful, virtually guaranteeing success.

Day	1	2	3	4	5	6
Pages	1	2	4	7		

Although 73 percent of teachers indicated that they had already taught the content required to answer this item correctly, only 34 percent of students did so. An additional 34 percent chose the suggested answer 13 pages, perhaps because they added three for each of the two days. Unfortunately, it is impossible to tell what operations students used in working on this problem, or whether they made a list or table to help them.

Item B25 Andrea delivered 3/4 of her party invitations by hand. Then she had 5 left to mail. How many invitations did she deliver by hand?

		% of students	
A)	5	26	
B)	10	18	
C)	15	26	*
D)	20	8	
E)	I don't know.	20	

Item B25, a non-routine problem involving fractions, proved to be one of the most difficult ones in the Assessment. The concepts involved, at least at an intuitive level, include a fraction of a set and the complement of a fraction. Representing the problem in a diagram like the one given below would have made it much easier to solve, but again it is impossible to tell what percentage of the students might have used this or any other heuristic.

By hand	By hand	By hand	5

Only 26 percent of the students answered this item correctly. A relatively large number, 20 percent, chose "I don't know." Teachers' responses to the opportunity to learn question based on this item suggest that they had concerns about the curricular validity of this item. Only 23 percent of the teachers indicated that they had already taught the needed content; 33 percent indicated that they would do so later in the year; but 42 percent indicated that it would be taught in a subsequent year or not at all.

The item with the lowest percentage correct of any item in the Number and Operations strand, and one of the lowest percentages correct overall, is Item A14, another non-routine problem. Interestingly, this item has a very high opportunity to learn rating, 82 percent of the teachers indicating that they had already taught the necessary content, and a very low percentage of "I don't know" responses from students, only 2 percent. The problem asked students to determine a digit missing from the subtrahend in a three-digit subtraction computation. Apparently 49 percent of the students failed to recognize that regrouping was required. Had these students checked their work, for example by subtracting the 259 from 457 or adding 259 and 208, they would have had evidence that their answer was wrong. Perhaps these students failed to recognize the importance of the check in the guess-and-check strategy.

Item A14 Find the missing digit:

$$\begin{array}{r} 4\ 5\ 7 \\ -\ 2\ \square\ 9 \\ \hline 2\ 0\ 8 \end{array}$$

		% of students	
A)	5	49	
B)	4	22	*
C)	0	22	
D)	6	4	
E)	I don't know.	2	

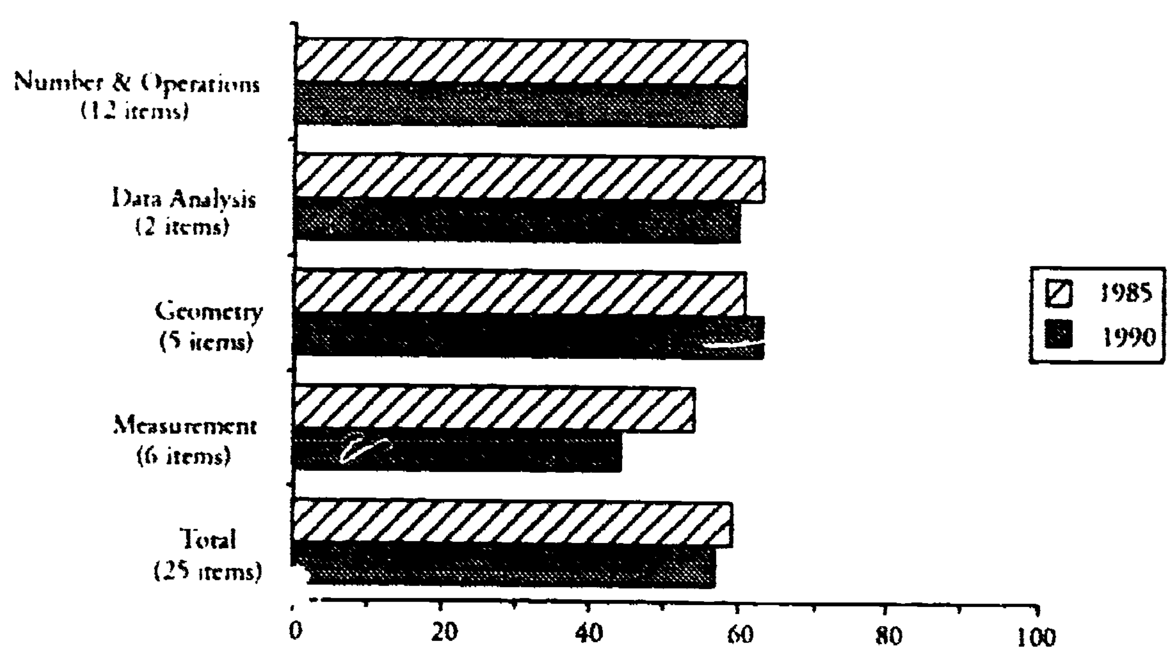
It is difficult to make generalizations about students' performance on problem-solving items, both because the items and the students' performance on them vary a great deal, and also because the number of items is not large enough to permit systematic study of the many features that may influence their difficulty. However, three patterns in the students' results can be seen, despite the fact that there are quite a few exceptions to each pattern. First, the students tended to

achieve a greater percentage correct on single-step translation problems than on multiple-step or multiple-condition problems, and a greater percentage correct on multiple-step problems than on ones that have been classified as non-routine. Second and similarly, the percentage of "I don't know" responses is lowest for single-step translation problems and highest for non-routine problems. Third, it also seems to be the case that students find problems with data presented pictorially easier than those with data presented in tables, and problems with data presented in tables easier than those presented only in words. It must be emphasized there are many exceptions to these generalizations, and the exceptions may be more interesting than the overall patterns. In a number of instances, evidence has been found to suggest that some students blindly applied computations to the numbers contained in the problems rather than reflecting on the meanings of data, whereas other examples show that some students failed to check their results for reasonableness.

Changes in Achievement

The 1990 Mathematics Assessment provided an opportunity to examine changes in the achievement of Grade 4 students between 1985 and 1990, since 25 items which had appeared on the 1985 Assessment were included in the 1990 instruments. Results on these change items are given by curriculum strand in Figure 4-3. This graph shows that, in general, the achievement of Grade 4 students was slightly lower in 1990 than in 1985. Both the overall difference of two percent and most of the differences in performance by curriculum strand are small, but the difference in performance on the Measurement strand and the differences on some individual items are noticeable. Detailed information about the differences in performance on the change items is provided in Appendix D, Table D-2.

Figure 4-3. Changes in achievement by strand.

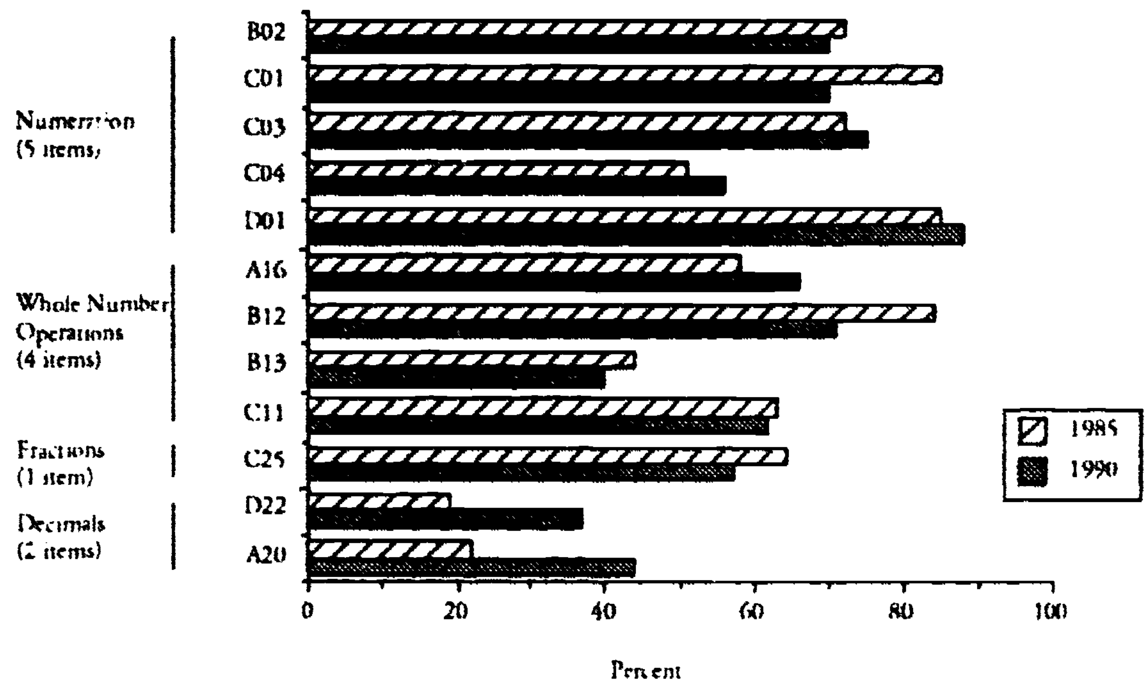


Differences in performance over time at the strand, topic, and item levels are discussed below. Caution should be exercised in interpreting these differenc-

es, especially where the number of items for a content area is small; the practical significance of a difference must always be considered. Note, for example, on a single item a change in performance of three percent represents a difference in the success on that item of only one student in a class of 33.

Students' overall performance on the Number and Operations strand and on the topics of Numeration and Whole Number Operations showed little change from 1985 to 1990. For the strand as a whole, the average percentage correct was 61 percent in both years. For the five items in the topic of Numeration, the average percentage correct was 73 percent in 1985 and 71 percent in 1990, whereas for the four items in the topic of Whole Number Operations, the average percentage correct was 62 percent in 1985 and 60 percent in 1990. However, as Figure 4-4 shows, even in these areas there were some conspicuous differences at the item level. For example, students' performance improved from 58 percent correct in 1985 to 66 percent correct in 1990 on Item A16, a multi-step word problem involving addition and subtraction.

Figure 4-4. Changes in achievement: Number and Number Operations.



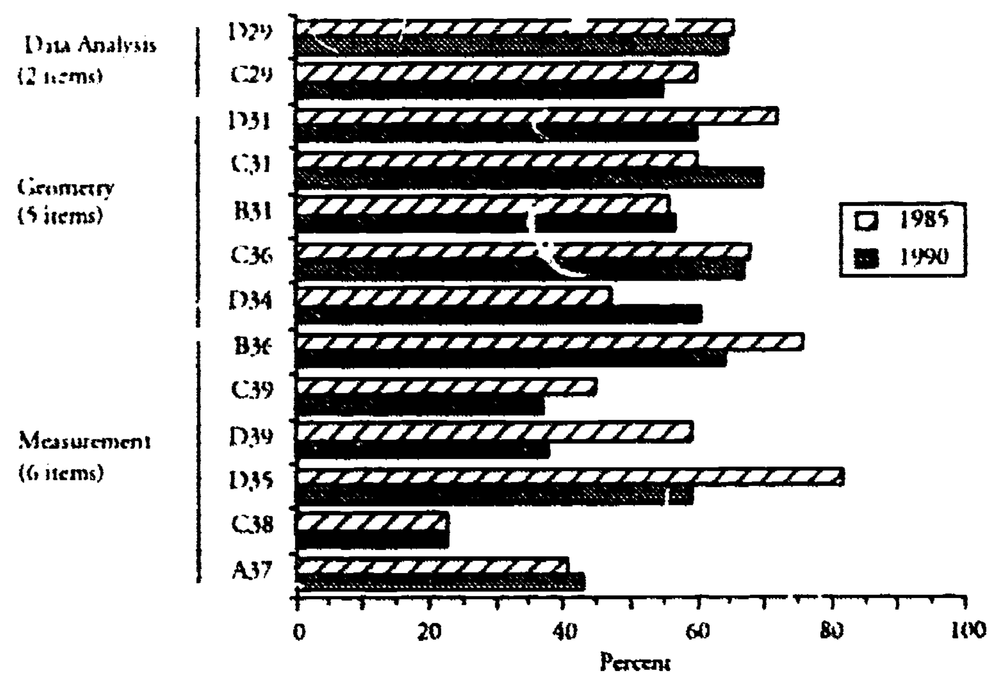
Item A16	Yesterday, Bella the whale ate a total of 98 fish in three meals. She ate 32 fish at the first meal and 25 fish at the second meal. How many fish did she eat for her third meal?			
		% of students		
A)	66	5		
B)	41	66	*	(1985 - 58%)
C)	155	9		
D)	57	12		
E)	I don't know.	7		

On the other hand, Item C01 and Item B12 each showed a decline from about 85 percent correct in 1985 to about 70 percent correct in 1990. Although the percentage of students getting these items correct is reasonably high in both years, the percentage of students getting them wrong has approximately doubled. Both problems are routine ones. Item C01 asked students "Which one of the following numbers says four thousand two hundred sixty-five?" and Item B12 directed them to find the product of 34 and 7. Students should have been quite familiar with both the content and form of presentation of these items.

Since 1985 there has been significant curricular change in elementary mathematics, occasioned by the introduction of the revised provincial curriculum in 1987. In the revised curriculum decimals are given increased attention in the early grades of the program, and it is encouraging to see that percentage correct on both item A20 involving decimal numeration to tenths and item D22 involving addition of decimals to tenths virtually doubling, from about 20 percent correct to about 40 percent correct. Although computations with fractions are de-emphasized in the revised curriculum, understanding of representations and of concepts such as equivalence remains prominent. Performance on Item C25 involving recognition of one-half of a set of discrete objects showed a disappointing but relatively small decline from 64 to 57 percent.

Given the increased emphasis that the revised curriculum places on data analysis, and graphing in particular, the declines in performance on items C29 and D29, shown in Figure 4-5, are likewise disappointing, but relatively small. For the Data Analysis strand as a whole, the average percentage correct decreased from 63 percent in 1985 to 60 percent in 1990.

Figure 4-5. Changes in achievement: Data Analysis, Geometry, and Measurement.



With the five items in the Geometry strand, the average percentage correct increased from 61 percent in 1985 to 63 percent in 1990. On two of the items, B31 and C36, the percentages correct were virtually unchanged from 1985 to 1990. On Item D31, which entailed the identification of line segments by the

letters of their endpoints, performance declined from 72 percent correct in 1985 to 60 percent correct in 1990. In the revised curriculum, this convention is not specifically mentioned as an intended learning outcome for Grade 4, but in one of the limiting examples given, one vertex of a polygon is labelled with a letter. Therefore, the current curricular validity of item D31 may be questioned. On two other geometry items, C31 and D34, there was a noticeable improvement in performance from 1985 to 1990. The percentage correct on Item C31, which asked students to identify the solid figure shaped like a soup can, rose from 60 percent in 1985 to 70 percent in 1990. On Item D34, 61 percent of the 1990 students correctly identified a line of symmetry in a rectangle, as compared with 47 percent of the students in 1985.

The Grade 4 students' average performance on the six change items in the Measurement strand was approximately 10 percent lower in 1990 than in 1985, 44 percent as compared with 54 percent. This difference is attributable to declines in performance on Item B36 involving length (centimetres and metres), Item C39 involving area (a figure drawn on squared paper), and Item D35 concerning volume (a drawing a single-layer solid). It is interesting to note that on items C38 and A37, on mass and temperature respectively, there was very little difference over the two years. On both of these items students were required to select an appropriate estimate for a measurement in metric units.

The two measurement items on which there was the largest decline in performance are item D39 on area and D35 on volume. Although both these items reflect intended learning outcomes found in the revised curriculum, they both had relatively low opportunity to learn ratings. Only 55 percent of the teachers indicated that the content needed to answer item D39 had already been taught in a previous year or earlier in the current year, and only 58 percent of the teachers indicated that the content needed to answer item D35 had already been taught. On the other hand, 23 percent of the teachers indicated that they did not plan to teach the content needed to answer item D39, and 16 percent of the teachers indicated that they would not teach the content needed for item D35. These data suggest that part of the reason for students' lower performance on these items may have to do with their teachers' view of their curricular appropriateness. If these two items are excluded from the comparison of performance over time, then on the remaining 23 items the average is 58 percent correct in both years. Thus it is fair to say that the small difference in overall achievement (57 percent to 59 percent on 25 items) can be accounted for by the difference in performance on two measurement items which have low opportunity to learn ratings.

Interpretation Panel Findings

The members of the Grade 4 Interpretation Panel were given the task of examining all of the achievement items and then assigning to each item the percentage of students they expected would get the item correct, and percentage of students they desired to get the item correct. After doing this as individuals, the Panel met in small groups and later in a large group and agreed to come to a consensus by giving a range between one multiple of five percent and the next for the expected percentage correct and the desired percentage correct on each item. For

example, the expected percentage correct might be 55 to 60 and the desired percentage correct 70 to 75.

For 94 of the 127 items (74 percent of the items) the desired percentage correct agreed upon by the Panel was 15 or 20 percentage points higher than the expected percentage correct. The median difference was 20 percent, the mean 18 percent.

The Interpretation Panel also compared their "expected" and "desired" percentages to the actual percentage of students who answered each item correctly and made observations and comments on the students' performance. Table 4-2 shows the number of items in each strand and topic and how the students' actual performance on those items compared with the expected and desired levels set by the Interpretation Panel. In the case of less than half of the items, the students' actual percentage correct was within five percentage points of Interpretation Panel's expected range. The actual percentage correct was more than five percent below the bottom of the range more than twice as often as it was above. The desired levels set by the Panel were such that in only three items did the students' actual performance exceed the desired level, and in only 11 items did it reach it.

Table 4-2. Interpretation Panel's expected and desired levels: numbers of items.

Strand and Topic	Total	Expected			Desired		
		Above	At	Below	Above	At	Below
Number & Operations	83	8	40	35	0	6	77
Number Concepts & Numeration	22	2	12	8	0	4	18
Whole Number Operations	38	3	17	18	0	1	37
Decimals	13	2	5	6	0	1	12
Fractions	10	1	6	3	0	0	10
Data Analysis	9	1	4	4	1	1	7
Geometry	17	9	3	5	2	4	11
Lines, Planes, Coordinates	6	2	0	4	0	0	6
Solid Figures	6	6	0	0	2	3	1
Relations and Transformations	5	1	3	1	0	1	4
Measurement	15[a]	1	9	5	0	0	15
Length	4	0	3	1	0	0	4
Area	4	0	2	2	0	0	4
Volume and Capacity	3	0	2	1	0	0	3
Mass	3	1	1	1	0	0	3
Time, Temperature, Money	1[b]	0	1	0	0	0	1
Total Curriculum-Related	124[c]	19	56	49	3	11	110
Number sense	3	3	0	0	0	3	0

(a) The total number of items for the measurement strand was 17; two items were not rated by the Interpretation Panel as to expected and desired levels of achievement.

(b) The two items not rated were on temperature and money.

(c) Of the total item pool of 129 items, two were not rated, and the three Number Sense items do not correspond to intended learning outcomes in the Grade 4 curriculum.

Categories of Student Performance

As explained in Chapter 2, the Interpretation Panel was also given the assessment items in four categories. These categories grouped the items according to the probability that students of varying abilities would be expected to answer the items correctly. Broadly speaking, the categories can be used to describe what students of varying abilities can do. This procedure is a departure from that followed in the three previous assessments, where the Panels judged student performance in each strand and topic to be strong, very satisfactory, satisfactory, marginal, or weak. The task that the 1990 Interpretation Panel was assigned was to examine the items in each category and characterize student abilities according to the items in the category. The challenge of this task is heightened by the fact that items having similar content and involving similar cognitive processes may differ in difficulty and therefore be assigned to different categories. Despite this complication, the Interpretation Panel prepared the following descriptions of four categories of mathematical ability. The percentages of students reaching the levels of performance described by the categories are given in Table 2-7 in Chapter 2.

Category 1: 95 percent of Grade 4 students

Students are able to demonstrate understanding of place value to 9999, to perform basic operations (addition, subtraction, and multiplication), and to use patterning. They can read and interpret data on a simple graph and determine the appropriate use of linear units (centimetres and metres). They demonstrate knowledge of geometry by identifying and analyzing attributes of some common plane and solid figures.

Category 2: 59 percent of Grade 4 students

In addition to the abilities in Category 1, students are able to demonstrate understanding of place value to 99 999; to solve multi-step problems; to read, write, and order decimals in hundredths; and to recognize common fractions. They can read and interpret bar graphs and pictographs. They can identify labelled line segments, cylinders, congruent figures, and lines of symmetry, and can tile a region using a shape. They can identify the number of centimetres in a metre, determine the volume of a figure by counting the cubes shown in a pictorial representation, and solve problems involving capacity.

Category 3: 21 percent of Grade 4 students

In addition to the abilities in Categories 1 and 2, students are able to demonstrate understanding of the number system. They can solve problems involving division of whole numbers, addition and subtraction of decimals, application of fractions, and analysis of data. They can solve measurement problems involving area, capacity, mass, and time. They can relate plane figures to composite plane figures and to solid figures, and they can recognize a slide (translation).

Category 4: 3 percent of grade 4 students

In addition to the abilities in Categories 1, 2, and 3, students are able to estimate by comparing known quantities to new situations involving millimetres or kilometres. They demonstrate understanding of transformational geometry including rotations, and can find the areas of rectangles and triangles drawn on squared paper. They can use higher-level thinking to solve complex problems.

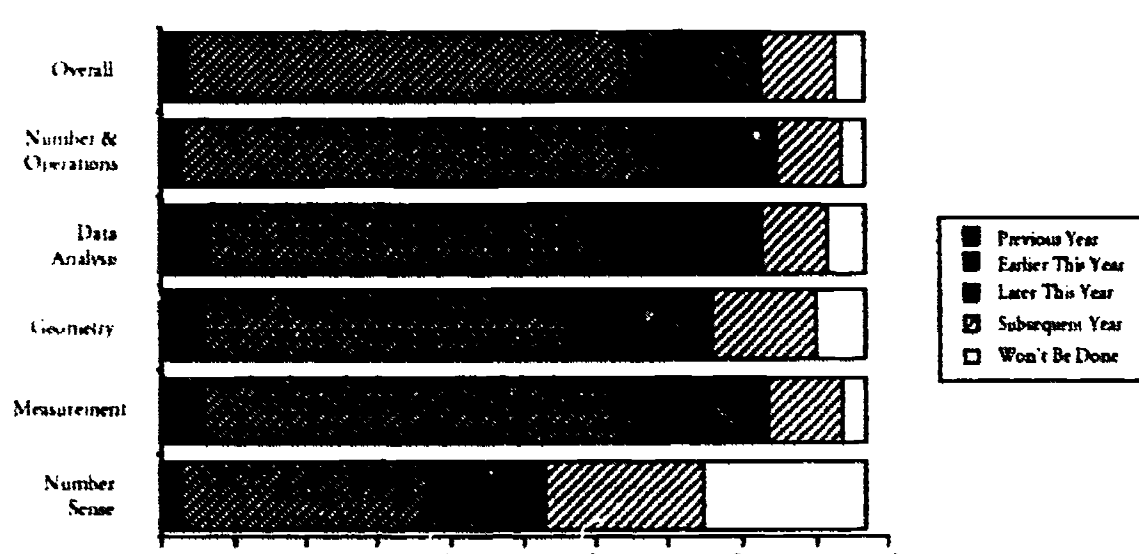
Opportunity to Learn

The teacher questionnaires contained items designed to gather information about whether or not students had had the opportunity to learn the mathematics reflected in items of the assessment. On each form teachers were asked to respond to 40 questions based on 20 selected achievement items from the student booklets. They were asked to review each item and estimate the percentage of the students in their class who would get the item correct and also to indicate whether or not they had taught the mathematics necessary to answer the item correctly. There were five achievement levels from which teachers could choose: 0-20, 21-40, 41-60, 61-80, or 81-100 percent correct. To indicate whether or not the mathematics had been taught, the teachers could choose one of the following statements: "It was done in a previous school year," "It was done during this school year," "It will be done later this year," "It will be done in a subsequent year," or "It will not be done for reasons not listed here." Data were collected for a total of sixty items, 57 measuring achievement in the curriculum strands and the three number sense items.

A summary of the results from these questions is presented in Figure 4-6. The top bar of Figure 4-6 shows opportunity to learn for the 57 curriculum-related items (excluding number sense items), the next four bars give the results by curriculum strand, and the bottom bar gives the results for the three number sense items.

The data presented in this figure have some disturbing implications. All

Figure 4-6. Opportunity to learn: by curriculum strand and overall.



items other than the three number sense items were judged by the members of the Contract Team and by the members of the Review Panels to correspond to intended learning outcomes up to Grade 4 listed in the curriculum guide published by the Ministry of Education (1987). Yet it appears that a sizable proportion of the teachers had not taught and do not plan to teach the mathematics needed to answer some of those items. Averaging over all teachers and over the 57 selected curriculum-related items included in the teacher questionnaires, 15 percent of the content was rated as "will be done in a subsequent year," or "will not be done." In the Geometry strand, 21 percent of the content was rated in these categories. It appears that teachers at large have a view of the appropriateness of certain curriculum content that differs from that of the curriculum developers, the Contract Team, and the Item Review Panel members. These data indicate that there is a discrepancy between the intended curriculum and the implemented curriculum for mathematics in Grade 4.

The assessment was administered during the week of May 14-18, 1990. At that time there were 29 school days or 15 percent of the school year remaining. However, 19 percent of the content (again averaging over all teachers and all 57 selected curriculum-related items) was rated as "will be done later this year." This analysis suggests that a substantial number of teachers would not be able to complete their intended curriculum by the end of the school year.

Table 4-3 shows the groupings of items by strand, and by topic where there were sufficiently many items on a single topic, along with the average ratings of opportunity to learn given by the teachers for each grouping. Caution must be exercised when attempting to draw detailed conclusions from these data. It should be noted, for instance, that not all curriculum strands and topics were sampled equally, and that not all achievement items were included in the assessment of opportunity to learn. As well, the items selected may or may not represent in a balanced way the entire range of learning outcomes for each strand and topic. Nonetheless, the results for the six items on decimals and for the five items on fractions suggest that at the time of the assessment a substantial fraction, nearly one-half, of the students had not been taught these two topics in sufficient depth. Similar findings seem to hold for two of the three topics in Geometry, Lines and Plane Figures, and Relations and Transformations, but in these topics

Table 4-3. Opportunity to learn: percent responding when mathematics content was taught.

	Number of items	Done in a previous year.	Was done this year.	Will be done later this year.	Done next year or later	Will not be done.
Overall	57	4	60	19	10	4
Number & Operations	32	3	65	17	9	4
Numeration	7	5	81	4	4	3
Whole Number Operations	14	3	73	11	6	4
Decimals	6	1	43	37	14	2
Fractions	5	3	46	26	19	4
Data Analysis	6	7	53	23	9	5
Geometry	11	4	53	21	12	6
Lines and Plane Figures	3	5	41	23	18	11
Solid Figures	4	6	64	17	8	3
Relations and Transformations	4	6	43	22	17	9
Measurement	8	3	69	18	7	3
Number Sense	3	3	34	16	22	22

there were only three items and four items, respectively.

Students' Attitudes and Opinions

Three groups of questions were used to gather information about students' attitudes, opinions, and beliefs. The first group contained three questions common to all four forms which sought information about students' beliefs and opinions regarding mathematics and jobs. This was followed by a group of multi-part questions on selected topics in school mathematics. On these items students were asked the degree to which they felt that selected topics in school mathematics were important, easy, and likable. A third group of questions was used to gather information about the frequency of various instructional practices in the mathematics classroom during a typical school week. The responses of the students to these items is discussed in the sections which follow.

Mathematics and Jobs

Students were asked three questions regarding their beliefs about and attitudes toward mathematics and jobs. They were asked whether they agreed or disagreed with the following statements: that one needed to be able to do mathematics to get a good job, that most people use mathematics in their jobs, and that when they left school they would like a job which required them to use mathematics. The responses are summarized in Table 4-4.

Table 4-4. Mathematics and jobs: percent responding.

Statement	Agree or strongly agree	Disagree or strongly disagree
You have to be able to do mathematics to get a good job when you grow up.	85	5
Most people use mathematics in their jobs.	82	6
When I leave school, I would like a job where I have to use mathematics.	54	18

Students' responses to these items indicate that most students believe that an ability to do mathematics is necessary to get and hold a good job, yet only about half of the students would like to have a job that requires them to use mathematics. These results are remarkably consistent with the responses of students in Grade 7, although even fewer of the Grade 7 students (42 percent as opposed to 54 percent) indicated interest having a job where they would have to use mathematics.

Topics in School Mathematics

Students responded to 12 multi-part items regarding topics in school mathematics. Each form contained four topics; on two forms the same four top-

ics were repeated. Students indicated how important they felt each topic was, how easy they found each topic, and how much they liked each topic, using five-point scales which ranged from "not at all important" to "very important," from "very difficult" to "very easy," and from "dislike a lot" to "like a lot." Students were instructed to omit items if they did not know what a topic meant. Results from these items are found in Table 4-5. The percentages reported in the table are the sums taken over the two positive points of each scale: "very important" and "important", "very easy" and "easy", and "like a lot" and "like"; and over the two negative points of each scale: "not at all important" and "not important", "very difficult" and "difficult", and "dislike a lot" and "dislike." The "undecided" responses and failures to respond are not reported.

Table 4-5. Opinions about topics in school mathematics: percent responding.

Topic	Important/ Not Imp.	Easy/ Difficult	Like/ Dislike
Adding, subtracting, multiplying, and dividing whole numbers	89 / 2	64 / 16	74 / 11
Learning about decimals	81 / 4	63 / 15	67 / 12
Learning about fractions	80 / 4	66 / 13	68 / 11
Learning how to estimate	77 / 7	70 / 13	68 / 13
Learning things about geometry like shapes, flips, turns, and slides	75 / 8	65 / 15	71 / 13
Checking answers	86 / 4	77 / 9	66 / 15
Using graphs	71 / 6	59 / 17	62 / 15
Learning about place value	78 / 4	56 / 18	58 / 16
Learning about measuring weight, height, length, and width	82 / 6	63 / 17	68 / 14
Learning how to use calculators	75 / 12	85 / 5	81 / 6
Using objects such as blocks, counters, and geoboards	53 / 18	70 / 9	56 / 20
Learning strategies for problem solving, such as looking for patterns and making models	76 / 7	49 / 26	64 / 15

Students' responses to the items on this scale indicate that the majority of students feel that all of the listed topics in school mathematics are quite important and that the traditional topics are of the greatest importance. Operations with whole numbers are given the highest importance rating. Place value, estimation, problem-solving strategies, calculators, geometry, and graphing are given lower importance. The lowest importance rating is given to using manipulative materials.

The majority of students found these mathematics topics easy. Learning to use calculators was rated easiest. Checking answers, estimating, and using manipulative materials were rated easier than measurement, computation, fractions, and decimals. Learning problem-solving strategies was rated as the most difficult.

The majority of students expressed liking for the topics listed. In general, students tended to like the topics that they found easy more than those that they found difficult, but the relation between difficulty and liking is not an especially

strong one. One topic that was an exception to this generalization was using manipulative materials, which was rated relatively easy but was the least liked. This topic was also given the lowest importance rating. Perhaps students have less liking for use of manipulative materials because they perceive it not to be an integral part of mathematics and hence a waste of time. Further research would be warranted to explore the nature of students' beliefs about manipulative materials and their role in mathematics and learning mathematics.

Mathematics Classroom Practices

Students responded to nine items dealing with classroom practices. Each form contained three of these items; on two forms the same three items were repeated. Students were instructed to think about their mathematics classes during a typical school week and indicate whether each activity took place "Almost every day", "Often", "Sometimes", "Rarely", or "Never". The items and student responses are summarized in Table 4-6. In this table the percentages given under the category "Frequently" represent the percentages responding "Almost every day" or "Often"; the percentages under "Seldom" are for the responses "Rarely" or "Never".

Table 4-6. Frequency of classroom practices: percent responding.

Statement	Frequently	Seldom
The teacher shows us what to do on the blackboard or overhead projector.	67	11
We use objects like blocks, counters, and geoboards.	12	55
We work individually on problems or other exercises the teacher assigns.	65	8
We use calculators.	11	56
We have quizzes or tests.	40	13
We review our homework and discuss the solutions.	57	18
We work in small groups.	31	27
We use computers.	34	35
The teacher helps individual students.	66	8

Students' responses to the classroom practices items suggest that most Grade 4 mathematics classes are traditional in nature involving review of homework and teacher lecture followed by individual seatwork with help from the teacher as needed. However, variations on this pattern are also seen. About one-third of the students indicated that they work in small groups "frequently," about one-third indicated that they did so "sometimes," and about one-third indicated that they "seldom" did so. Surprisingly, a similar distribution of responses was found with respect to computer usage. This is in marked contrast to the results for Grade 7 students, only five percent of whom reported using computers frequently in their mathematics classes and 85 percent of whom seldom used computers in their mathematics class.

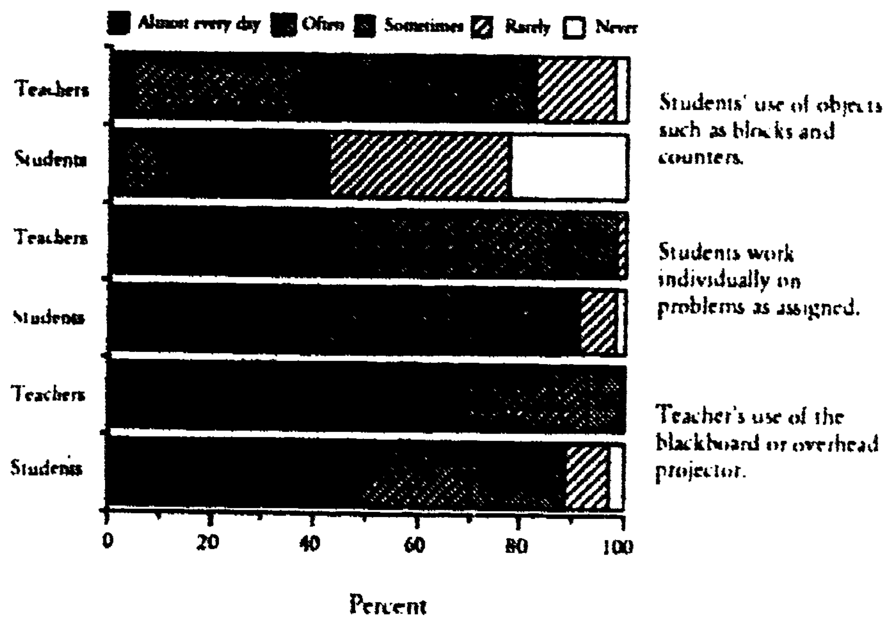
A prominent feature of the revised curriculum guide (1987) is its inclusion of a "Statement on Calculators" (p. 7) which indicates that the curriculum

was developed "assuming that all students will have access to calculators." It recommends that "at the primary level, the calculator should be used for exploratory activities," and it points out that some intended learning outcomes (ILOs) indicate explicitly that students should use a calculator, and other ILOs leave calculator usage to the discretion of the teacher. Despite this strong curricular support for calculators, nearly three-fifths of the students indicated that they rarely or never use calculators in their mathematics classes.

Another emphasis of the revised curriculum guide (1987) is experience with manipulation of concrete materials. This emphasis is found explicitly in the rationale and in various intended learning outcomes. However, student reports of classroom practices suggest that concrete materials are seldom used: 55 percent of the students responded that they "rarely" or "never" use objects like blocks, counters, and geoboards; only 12 percent responded that they do so frequently.

The teacher questionnaires, described in Chapter 3, also contained three classroom practices items very similar to the first three student items mentioned above. The remaining student items were not presented to the teachers as a result of an error in assembling the final forms of the teacher questionnaires. Comparison of teachers' responses with students' responses on the three common items, shown in Figure 4-7, suggests that teachers generally rated all of the classroom

Figure 4-7. Teachers' and students' reports of classroom processes.



practices as occurring more frequently than students rated them. Furthermore, teachers almost never said that they "never" use the practices mentioned, although some students did select "never."

The most striking discrepancy between teachers' and students' reports of classroom practices is seen in the items about the use of manipulative materials. Students were asked how frequently "We use objects like blocks, counters, and geoboards," whereas teachers were asked how frequently "Students use objects like blocks and counters." The proportion of teachers who say they use manipulatives "almost every day" or "often," 36 percent, corresponds roughly to the proportion of students who say they use them "almost every day" or "often" or

"sometimes," 40 percent; while the proportion of teachers who use manipulative materials "sometimes," 43 percent, corresponds to the proportion of students who use them "rarely," 33 percent; and the proportion of teachers who use manipulative materials "rarely" or "never," 18 percent, corresponds to the proportion of students who "never" use them, 22 percent.

Correlates of Achievement

In this section, various aspects of the achievement of different groups of students are compared, those groups being constructed on the basis of students' responses to background questions and questions about their beliefs and attitudes towards mathematics and about instructional practices in their mathematics classes. In each of these comparisons, it may be tempting to think of achievement as the dependent variable with some other trait, attitude, or opinion being taken as the independent variable. However, it is important to emphasize that this is a study of correlations, not an experimental study, and, of course, correlation does not necessarily imply causation. In fact, there may even be some cases where there exists a causal relationship operating in the opposite direction. For example, teachers' perceptions of their students' abilities, and hence their achievement, may determine the classroom practices the teachers adopt, rather than those classroom practices affecting positively or negatively the students' achievement.

Gender Differences

Differences in mathematics achievement between males and females have

Table 4-7. Differences in achievement for males and females.

Strand or Topic	Percent Correct: Males	Females	Total
Number & Operations	51	50	50
Number Concepts & Numeration	53	53	53
Whole Number Operations	57	54	55
Decimals	40	43	41
Fractions	47	47	47
Data Analysis	44	47	45
Geometry	60	61	60
Lines, Plane Figures, Coordinates	42	44	43
Solid Figures	72	72	72
Measurement	50	46	48
Length	74	70	72
Area	39	38	38
Volume and Capacity	56	48	52
Mass	33	27	30
Time, Temperature, Money	48	44	46
Number sense	19	20	20
Total	51	50	51

been reported in a number of studies carried out around the world. Generally speaking, the size and direction of the difference depends upon factors such as the country, the age of the students, the topic, and the number of items involved. In the 1985 British Columbia Mathematics Assessment very little difference was found between Grade 4 boys' and girls' achievement . and that finding is borne out in the 1990 Assessment. The overall percentage correct was 51 percent for the boys and 50 percent for the girls. As Table 4-7 shows, the differences within strands and topics were also small, but tended to be larger where the number of items was small. Some differences at the strand and topic levels favored the boys, whereas others favored the girls.

Program Differences

The vast majority of Grade 4 students in British Columbia are enrolled in the regular English program, about seven percent are enrolled in Early French immersion, and about one percent in *Programme-cadre de français.* Students who receive mathematics instruction in French were instructed to respond to French versions of he Assessment booklets. Approximately five percent of the students responded to French booklets, and 95 percent responded to English booklets. Differences in mathematics achievement among students in the three programs were quite small, with the results of the Immersion students slightly above and the results of the *Programme-cadre de français* students slightly below those of the majority in most strands and topics. The overall percentage correct was 51 percent for students in the English program, 52 percent for students in French immersion, and 48 percent for students in *Programme-cadre de français.* The difference in overall percentage correct between students who responded to booklets in French and students who responded to booklets in English was less than one percent.

Students' Attitudes

A number of aspects of students' attitudes and opinions were explored in the background information questions at the beginning of each booklet, and detailed analyses have been carried out of relationships between responses to those questions and achievement overall and in various strands and topics. Generally speaking, students with more positive attitudes have higher achievement than students with less positive attitudes, but it is impossible to say whether poor attitudes cause lower achievement or are the result of lack of success. Perhaps both processes are at work.

Three questions explored students' beliefs about mathematics and jobs; students were asked whether they agreed or disagreed with the statements (1) that you have to be able to do mathematics to get a good job when you grow up, (2) that most people use mathematics in their jobs, and (3) that they would like to have a job where they have to use mathematics when they leave school. The overall achievement of the students who agreed or strongly agreed with the first statement was 53 percent correct, whereas the students who disagreed or strongly disagreed with the first statement scored 47 percent correct. Virtually the same difference in achievement was found with respect to the second and third ques-

tions as well. Differences at the strand and topic levels were similar, but where the numbers of items were smaller, the differences were less consistent.

Another series of multi-part items asked students to indicate whether they felt that selected topics in school mathematics were important, easy, and likable. In general, students responding positively to questions about the importance of various topics had higher achievement than students responding negatively. For example, the students who indicated that adding, subtracting, multiplying and dividing whole numbers was important or very important scored an average of 53 percent correct overall, whereas those who responded that this topic was unimportant scored 42 percent correct. There were similar differences between groups of students with respect to specific strands and topics. For example, students who rated learning about decimals important outscored those who rated decimals unimportant by 43 percent to 32 percent correct in that topic. The findings with respect to the importance of learning about fractions and achievement in fractions were similar. However, on the question of the importance of estimation, a different pattern was found. The overall achievement difference between students responding that estimation is important and those responding that it is unimportant was only 53 percent to 50 percent, and comparably small differences were found at the strand and topic levels.

With respect to the questions about the difficulty of various topics, it was found that the difference in achievement between those who found each topic easy and those who found the topic difficult was about ten percent. For example, students who indicated that learning how to estimate was easy outscored those who indicated that learning how to estimate was difficult by 55 percent correct overall to 44 percent correct. The differences in overall achievement between students who liked each topic and students who disliked the topic were generally smaller. For example, students who expressed liking for learning about decimals scored 54 percent correct overall, but those who disliked learning about decimals scored 49 percent. However, the differences in achievement on a particular topic between students who expressed liking for that particular topic and those who did not was on the order of ten percent. For example, students who expressed liking for decimals outscored those who did not by 45 percent to 35 percent on items involving decimals.

Classroom Practices

As was reported in a previous section, students were asked to indicate how frequently various instructional practices were used in their mathematics classes. Numerous analyses of relationships between students' responses to these questions and their achievement overall and in various strands and topics have been carried out. Details may be found in Tables D-3 to D-14 of Appendix D; highlights are presented in this section.

For six of the nine classroom practices surveyed, a clear majority of the students reported that the practice occurred either frequently (i.e., "almost every day" or "often") or seldom (i.e., "rarely" or "never"), but for the remaining three classroom practices the distribution of responses across frequency categories was relatively flat. The first correlations between classroom practices and achievement to be considered are those for which a majority of the students indicated that the

practice occurs frequently.

Students' responses to the statement "The teacher shows us what to do on the blackboard or overhead projector" indicated that this practice occurred frequently for a majority of the students, 67 percent, and seldom for a minority of the students, 11 percent. The overall average achievement for those students reporting that the practice occurred frequently was 54 percent correct, but the overall average achievement for students reporting that the practice seldom occurred was 48 percent correct. Similar patterns were found with respect to the statement,"We work individually on problems or other exercises the teacher assigns." The overall average achievement for the 65 percent of the students who indicated that this practice was adopted frequently was 54 percent correct, as opposed to 47 percent correct overall for the eight percent of the students who reported that this process was seldom used.

Review and discussion of homework, and individual help from the teacher were also reported as frequently experienced by a majority of the students, but for these classroom processes there was very little difference in achievement between those students who indicated that the practice occurred frequently and those who indicated that the practice seldom occurred. The overall average achievement for the 57 percent of the students who indicated that "We review our homework and discuss the solutions frequently" was 54 percent correct, as compared with 53 percent correct overall for the 18 percent of the students who reported that this process seldom occurred. The overall average achievement for the 66 percent of the students who indicated that "The teacher helps individual students frequently" was 53 percent correct, the same percentage as for the eight percent of the students who reported that this process seldom occurred.

Two classroom processes, use of manipulative materials and use of calculators, occurred "rarely" or "never" in the classrooms of a majority of the students, and in both cases the achievement of the majority of the students was greater than the achievement of the minority. Fifty-five percent of the students responded that they seldom "use objects like blocks, counters and geoboards." Those students scored an average of 54 percent correct overall, but the 12 percent of the students who indicated that they use such materials frequently scored an overall average of 48 percent correct. Similarly, 56 percent of the students responded that they seldom use calculators, and that group of students scored an average of 54 percent correct overall, whereas the 11 percent of the students who indicated that they use calculators frequently scored an overall average of 48 percent correct.

The three classroom processes on which there was no clear consensus regarding the frequency with which they occurred were administration of quizzes and tests, work in small groups, and use of computers. For these processes, relatively large numbers of students, 31 to 47 percent, responded by choosing the middle alternative, "sometimes." Differences in achievement among these students and those who indicated that the practices occurred frequently and those students who indicated that the practices seldom occurred were fairly small. One of the differences in achievement favored the group that reported that the practice occurred frequently, but the other two favored the group that reported that the practice seldom occurred.

Forty percent of the students responded that they "have quizzes or tests" frequently; these students scored 54 percent correct overall, as compared with 50 percent correct overall for the 13 percent of the students who indicated that they seldom have quizzes or tests. On the other hand, the 31 percent of the students who indicated that they frequently work in small groups scored lower overall than the 27 percent of the students who indicated that they seldom work in small groups; the difference in achievement for these two groups was 51 percent correct to 55 percent correct.

The overall percentage correct for those students who indicated that they use computers frequently was 52 percent, as opposed to 54 percent correct overall for those students who reported that they seldom use computers. The percentages correct for both these groups exceed the percentage correct for the entire population, suggesting that the students who reported that they "sometimes" use computers had lower achievement than average.

Taken together, the results of the analyses of correlations between classroom practices and achievement suggest not only that most instruction is traditional in nature emphasizing review and discussion of homework, teacher demonstration of content, individual seatwork, and help for individuals as needed, but also that achievement is higher in classes taught with these processes than in non-traditionally taught classes. The observation that use of manipulative materials and use of calculators are negatively correlated with achievement is disconcerting at first glance in view of the fact that these processes are advocated in the revised curriculum. However, it is important to re-emphasize that such correlations do not necessarily imply that the instructional practices have caused the differences in achievement. An equally plausible explanation is that when working with students of lower achievement, the teachers have adopted non-traditional practices such as use of manipulative materials, group work, and use of calculators in the belief that such practices have the greatest likelihood of success with those students. Further research is needed to determine which of these relationships, if any, are causal relationships.

Summary

The 1990 British Columbia Mathematics Assessment instruments for Grade 4 consisted of four student booklets each containing 40 achievement items drawn from a pool of 129 items grouped into 12 topics in four strands. Each booklet also contained items designed to gather data on student background, attitudes, and classroom practices. The achievement items covered topics currently prescribed in the British Columbia mathematics curriculum up to Grade 4. An additional three items assessed what was termed "number sense". Ten achievement items were repeated on all forms of the student booklets.

The overall percentage correct was 51 percent on each of the four forms. Students had a greater percentage correct on items in numeration, whole number operations, and geometry, and a lower percentage correct on items in decimals, fractions, data analysis, and measurement. Within each strand and topic, students' performance on individual items has been analyzed to determine factors influencing students' probability of success and to identify patterns and causes of errors. In general, students achieved a greater percentage correct on computation-

al items than on problems and applications. Differences were also seen in students' performance on routine single-step problems, multiple-step problems, and non-routine problems.

An Interpretation Panel was convened and charged with the task of setting expected and desired levels of achievement for each item. Students' actual results tended to be somewhat lower than the Interpretation Panel's expectations, and were noticeably lower than the desired levels set by the Panel.

For approximately half of the student achievement items, analyses of opportunity to learn were carried out by means of items on the teacher questionnaires. Teachers were asked to indicate whether the content needed to answer the item correctly had been taught in a previous year or earlier in the current school year, or whether it would be taught later in the year, in a subsequent year, or not at all. Analyses of data from these items indicated that low opportunity to learn ratings were often associated with relatively low student performance, and conversely that high opportunity to learn ratings tended to be associated with relatively high student performance, but numerous exceptions to this generalization were also pointed out.

Changes in Grade 4 students' performance from 1985 to 1990 were analyzed with 24 items that appeared in the 1985 Assessment and were included in the 1990 booklets as well. The overall performance was approximately three percent lower in 1990 than in 1985. The differences in performance over time were small in all strands except Measurement; on some items the performance improved while on others it declined.

Analyses of correlations between students' achievement and their responses to background questions and questions about beliefs and attitudes towards mathematics and about instructional practices in mathematics classes were carried out. Differences in achievement between boys and girls and between students in different programs were very small. Students who demonstrated positive attitudes generally had higher achievement than students with less positive attitudes. It was found that traditional teaching practices such as review and discussion of homework, teacher demonstration of content, individual seatwork, and help for individuals were very prevalent, and that students who reported experiencing traditionally taught classes had higher achievement than students who reported frequent occurrence of non-traditional practices such as use of concrete manipulative materials, use of calculators, and work in small groups. These correlations do not necessarily indicate a causal relationship between instructional practices and student achievement.

References

Ministry of Education (1987). *Mathematics Grades 1-8. Curriculum Guide.* Victoria: Curriculum Development Branch.

Ministry of Education (1988). *Mathematics Grade 7-12.* Victoria: Program Development Division.

Robitaille, D. F. & O'Shea, T. J. (Eds.) (1985). *The 1985 British Columbia Mathematics Assessment: General Report* Victoria, B. C.: Ministry of Education.

Chapter 5

Grade 7 Results

Leslie H. Dukowski

The results of the 1990 Provincial Assessment of Mathematics for Grade 7 are presented and discussed in this chapter. First, the instruments used are briefly discussed. This is followed by a description of the student population including information gained from scales dealing with students' attitudes towards mathematics and their reports of instructional practices. Achievement results and Interpretation Panel observations are presented for each strand and topic. Student performance on items dealing with number sense and non-routine problems is discussed, and this is followed by information on changes in achievement between 1985 and 1990. Achievement results by reporting category are then discussed. A summary is found at the end of the chapter. Sample items have been used to exemplify points made throughout the text but space limitations do not allow every item to be presented. All percentages in the chapter have been rounded to the nearest whole percent.

The Grade 7 Interpretation Panel examined all of the items in the assessment booklets individually and then as a group assigned to each item the expected percentage and desired percentage of the students who would get the item correct. The Panel then compared the actual percentage of students who answered the items correctly and commented on student performance.

Each Grade 7 mathematics teacher completed one of three forms of a teacher questionnaire. This questionnaire contained, among other things, questions designed to gather information about students' opportunity to learn the mathematics necessary to answer assessment items correctly. The opportunity to learn information is discussed in the section describing the instruments and also in the discussion of individual items in the strand and topic sections where appropriate.

As explained in Chapter 2, the Panel was also given the assessment items assigned to four categories. The categories grouped items according to the probability that students of varying abilities were expected to answer the items correctly. Broadly speaking, the categories are descriptions of what students of varying abilities can do. This procedure is a departure from that followed in the past three assessments.

Description of the Instruments

There were 142 achievement items contained in the Grade 7 student booklets. Of these 142 items, 138 were used to measure student achievement in six strands: Whole Numbers, Rational Numbers, Data Analysis, Geometry, Measurement, and Algebra. The strands were further divided into a total of eighteen objectives. Items were chosen to correspond to intended learning outcomes up to Grade 7 as listed in the *Mathematics 1-8 Curriculum Guide* (1987) published by the British Columbia Ministry of Education. The remaining four items do not strictly match intended learning outcomes and were selected to evaluate what was termed "number sense".

The 142 achievement items were distributed among four forms, A, B, C, and D, so that the estimated difficulties for each form were approximately equal. Each booklet contained roughly the same number of items from each strand. Of the 40 achievement items in each booklet, six items, one in each strand, were common to all forms.

Each student booklet contained seven common background questions. Students were asked to report their gender, age, program (English, Early or Late French Immersion, or *Programme-cadre de français*) and language of instruction. Three other questions requested information about students' opinions regarding the usefulness of mathematics for getting and keeping a job.

Students' attitudes towards topics in school mathematics were measured with twelve questions distributed among the four booklets. These questions asked the degree to which students felt that particular topics in school mathematics were important, difficult, or enjoyable. Forms A and B each contained four of these questions and Forms C and D repeated the remaining four.

Nine items were used to gather information about classroom practices including the use of calculators and computers, teacher use of blackboard and overhead projector, use of manipulatives, small group and individual work, review of homework, and use of the textbook. Forms A and B each contained three of the items and Forms C and D repeated the remaining three.

Organization of Achievement Items

All achievement items were multiple-choice and had five response choices. Four of the choices were possible answers and the fifth was "I don't know." Students marked their answers on answer sheets constructed specifically for the assessment.

About 400 test items were developed during the spring of 1989. Many items were written specifically for this assessment, but some were drawn or adapted from a number of sources including those items made public by the National Assessment of Educational Progress (NAEP) in the United States, the Ontario Assessment Instrument Pool for Mathematics, Intermediate Division, and items developed previously for the Provincial Learning Assessment Program of the B.C. Ministry of Education. Some items, designated as change items, were repeated from the 1985 Assessment.

Items were categorized into Knowledge, Comprehension, Application, or Problem Solving in order to ensure that a reasonable range of item types were represented in the booklets. All items were reviewed by the Advisory Committee and by Review Panels in Richmond and Prince George in the spring of 1989. New or modified items were pilot tested in the fall of 1989. Table 5-1 shows the distribution of items by strand and cognitive level.

Forty-four items which appeared in the 1990 Mathematics Assessment were drawn from the 1985 Assessment instruments and can therefore be used to measure changes in student achievement between 1985 and 1990. These items

Table 5-1. Distribution of achievement items by cognitive level.

Strand	Knowledge	Comprehension	Application	Problem Solving	Total
Whole Numbers	6	7	3	1	17
Rational Numbers	23	8	16	2	49
Data Analysis	5	7	5	0	17
Geometry	9	6	6	2	23
Measurement	4	3	6	3	16
Algebra	4	11	0	1	16
Total	51	42	36	9	138

were organized into eight change categories. Results are discussed later in the chapter.

Opportunity to Learn

Teachers were asked to respond to a series of questions designed to gather information about whether or not students had had the opportunity to learn (OTL) the mathematics reflected in items in the assessment booklets. A total of 59 OTL items were distributed among the three teacher questionnaires, 20 items per form, with one item repeated on two questionnaires. Teachers were asked to review each item and estimate the percentage of the students in their classes who would get the item correct and also to indicate whether or not they had taught the mathematics necessary to answer the item correctly. There were five achievement categories from which teachers could choose: 0-20%, 21-40%, 41-60%, 61-80%, and 81-100%. The teachers also chose among the following statements to indicate whether or not the mathematics had been taught:

It was done in a previous school year.
It was done during this school year.
It will be done later this year.
It will be done in a subsequent year.
It will not be done for reasons not listed here.

The OTL results are summarized in Table 5-2. Not all strands or topics were sampled equally. For reporting in the table the items are grouped by topic if there were five or more items for that topic. Note that the three problem-solving items that appeared on the teacher questionnaires have been removed from groupings and shown separately as is the single Number Sense item. The table contains the number of items in each grouping.

The data in this table point up some disturbing trends. The assessment was administered in the week of May 14-18, 1990. At that time there were only 29 school days or 15 percent of the school year remaining. According to the *Mathematics 1-8 Curriculum Guide* integers, data analysis, geometry, and algebra are allotted 10, 10, 12, and 8 percent of the instructional time respectively. It appears that some teachers would not finish the prescribed curriculum by the end of the school year. Of greater concern is the observation that 16 percent of the teachers believe that integers will be covered in a subsequent grade or not at all. Over a quarter of the teachers believe the same is true for geometry and data analysis and yet all of the items reflect prescribed curriculum for Grade 7.

Table 5-2. Opportunity to learn (percent responding when mathematics content was taught).

	Number of items	Done in previous year (%)	Done this year (%)	Later this year (%)	Next year or later (%)	Will not be done (%)
Operations with Whole Numbers/Theory of Numbers	4	4	86	7	2	3
Fractions and Decimals	3	3	87	7	1	1
Topic 2.3: Ratio, Proportion, and Percent	7	3	74	20	1	1
Topic 2.4: Integers	7	5	40	39	12	4
Strand 3: Data Analysis	10	9	36	30	13	13
Topics 4.2 & 4.3: Similarity & Analytic Geometry	8	11	35	29	13	13
Strand 5: Measurement	8	10	80	6	2	2
Strand 6: Algebra	8	3	69	18	7	3
Problem Solving	3	63	12	7	11	11
Number Sense	1	31	45	7	3	14

Description of the Population

All students enrolled in Grade 7 except those identified by school principals as unable to respond to a paper-and-pencil test were required to complete one of the multiple-choice assessment booklets. Only students designated as dependently handicapped, moderately mentally handicapped, severely and profoundly handicapped, or autistic were to be excluded. Principals were instructed to ensure that all students in the English program, the Early and Late French immersion programs and in *Programme-cadre de français* classes were included.

Age, Gender, Program, and Language of Instruction

The data show that the majority of students in Grade 7 were either 12 or

13 years old at the time that the assessment was conducted: 50 percent and 45 percent respectively. Less than 1 percent of the students reported ages under 12 years and less than 5 percent reported ages over 13 years. The numbers of boys and girls were almost equal.

British Columbia offers three distinct programs of instruction other than the regular Grade 7 program in English: Early French Immersion, Late French Immersion, and *Programme-cadre de français*. The English program enrolls 93 percent of the students responding to the assessment. Early French Immersion, Late Immersion, and *Programme-cadre* enroll 4 percent, 2.5 percent, and 0.5 percent respectively.

The assessment booklets were translated into French for those students whose language of mathematics instruction was French. Just over 5 percent of the students responded to the booklets in French.

Mathematics and Jobs

Students were asked three questions regarding the importance of mathematics in getting and keeping a job. They were asked whether or not one needed to be able to do mathematics to get a good job, whether or not most people used mathematics in their jobs, and whether or not when they left school they would like a job which required them to use mathematics. The responses are summarized in Table 5-3.

Table 5-3. Mathematics and jobs: (percents).

	Agree or Strongly Agree	Disagree or Strongly Disagree
You have to be able to do mathematics to get a good job.	89	5
Most people use mathematics in their jobs.	87	5
When I leave school, I would like a job where I have to use mathematics.	42	20

Responses to these items indicate that most students believe that an ability to do mathematics is necessary to get a job, yet less than half of the students would like to have a job that requires the use of mathematics.

When the responses to these items are analyzed by gender, there is little difference in the pattern of responses for the questions regarding the necessity to be able to do mathematics to get a job and the use of mathematics in jobs. For the third item which asked whether or not the student would like a job that required the use of mathematics, 45 percent of the boys responded positively compared to 39 percent of the girls.

Topics in School Mathematics

Students responded to nine items distributed among the four booklets regarding topics in school mathematics. Students indicated how important they felt each topic was, how easy they found each topic, and how much they liked each topic. The responses were made on five-point scales which ranged from "not at all important" to"very important", "very difficult" to "very easy", and "dislike a lot" to "like a lot". Students were instructed to omit responses if they did not know what a topic meant. Results from these items are found in Table 5-4. The percentages reported in the table are the sums taken over the two positive points of each scale:"very important" and "important"; "very easy" and"easy"; and "like a lot" and "like" and over the two negative points of each scale: "not at all important" and "not important"; "very difficult" and "difficult"; and"dislike a lot", and "dislike".

Student responses to the items on this scale indicate that the majority of students feel that all of the topics listed are important and that the traditional

Table 5-4. Student attitude toward topics in school mathematics (percent).

	Important/ Not Important	Easy/ Difficult	Like/ Dislike
Learning geometry	70 / 10	60 / 21	57 / 24
Working with data and graphs	72 / 8	58 / 17	57 / 19
Learning to use calculators	75 / 15	93 / 2	84 / 5
Learning strategies for problem solving like looking for patterns and making models	75 / 8	38 / 32	46 / 30
Adding, subtracting, and multiplying fractions	83 / 6	72 / 12	56 / 5
Adding, subtracting, and multiplying decimals	86 / 4	73 / 12	56 / 5
Working with percents	87 / 3	59 / 17	56 / 20
Learning about estimation	72 / 11	76 / 8	52 / 25
Memorizing basic facts	91 / 2	65 / 17	50 / 24
Solving equations	89 / 3	59 / 18	53 / 26
Working with perimeter, area, and volume	77 / 7	60 / 21	50 / 30
Working with integers	57 / 9	47 / 15	40 / 20

topics of basic facts and computation with fractions and decimals are of the greatest importance. Working with integers, learning geometry, working with data and graphs, and learning about estimation are given the lowest importance ratings. This ranking of topics by importance is consistent with findings in the 1985 Assessment.

Students find learning to use calculators, computation, and estimation the easiest topics, and learning problem-solving strategies, geometry, perimeter, area, and volume the most difficult. Students also tend to dislike these topics which they find difficult. Once again, these findings are consistent with similar data collected in the 1985 Assessment.

When the attitude data are analyzed according to gender, there are only minor differences between boys' and girls' attitudes about the mathematics learned in school as measured in the Mathematics in School scale. The differences in attitudes are each less than five percentage points on all topics except for problem-solving strategies and perimeter, area, and volume. Boys reported, by a margin of about seven percentage points, that they enjoyed these topics more than girls.

Classroom Practices

Students responded to nine items dealing with classroom practices distributed among the four booklets. Each booklet contained three of the items. Students were instructed to think about their mathematics classes during a typical school week and indicate whether the activity took place "Almost every day", "Often", "Sometimes", "Rarely", or "Never". The items and student responses are summarized in Table 5-5. The percentages for "Frequently" are sums taken across the responses for "Almost every day" and "Often", the percentages for "Seldom" are sums taken across the responses for "Rarely" and "Never".

Table 5-5. Frequency of classroom practices.

	Frequently	Seldom
We use computers in our mathematics class.	5	85
The teacher helps individual students.	73	6
We review our homework and discuss solutions.	77	8
The teacher shows us what to do on the blackboard or overhead projector.	81	8
We work individually from our textbooks or on other exercises the teacher assigns.	83	5
We use calculators.	19	46
We have quizzes or tests.	39	11
We work in small groups.	31	43
We use objects like blocks, counters, fractions bars, and geoboards.	4	83

Students' responses to the classroom practices items suggest that most Grade 7 mathematics classes are fairly traditional, with time for review of homework, teacher lecture, and then individual seatwork and help from the teacher. It is clear that from these student reports that there is little use of manipulative materials or calculators in classes and that computers are almost never used in mathematics classes.

Levels of Student Performance

Chapter 2 contains an explanation of how items were categorized into performance levels. The Interpretation Panels examined the items in each of the levels and characterized student abilities as evidenced by the items in the category. The Interpretation Panel's descriptions are found below.

Category 1

Students are able to solve exercises involving place value, subtraction of mixed numerals, and multiplication of whole numbers, and they can rename numbers and fractions or ratios. They understand properties of angles involving measurement and congruency and can solve one-step problems involving length, volume, and capacity. An estimated 98 percent of Grade 7 students would correctly answer (at least 7 times out of 10) the least difficult item in Category 1.

Category 2

In addition to Category 1, students are able to perform simple operations with proper fractions and sight multiplication with powers of ten. They can rename percents as fractions or decimals and can use percent in problem solving. They can display and interpret data using bar graphs, broken line graphs, or circle graphs. They are able to apply geometric terms, use estimation skills to determine area and mass, and rename metric units. They can translate written statements into algebraic expressions and can solve whole number algebraic equations. An estimated 66 percent of Grade 7 students would correctly answer (at least 7 times out of 10) the least difficult item in Category 2.

Category 3

In addition to Category 2, students can use expanded notation, standard form, estimation, and can perform order of operations with whole numbers and decimals. They can solve two-step problems involving ratio, multiples, area, or mass. They can calculate the area of rectangles and triangles and apply properties of symmetry and similarity. They can perform transformations and can determine the coordinates of an image after a transformation. They can display data using frequency tables and interpret the median of a set of data. They can solve problems using charts, lists, diagrams, and can identify patterns. They can use inverse operations to solve percent and algebraic equations. An estimated 40 percent of Grade 7 students would correctly answer (at least 7 times out of 10) the least difficult item in Category 3.

Category 4

In addition to Category 3 above, students are able to solve a variety of

multi-step problems. They can identify mode or median from data and interpret data displayed on a stem-and-leaf plot. They can locate coordinates on a Cartesian plane. An estimated 5 percent of Grade 7 students would correctly answer (at least 7 times out of 10) the least difficult item in category 4.

Achievement Results

Strand 1: Whole Numbers

By the end of Grade 7 students are expected to be proficient in the four basic operations of addition, subtraction, multiplication, and division with whole numbers. Students are also expected to understand number concepts and to be able to apply these skills and understandings in real world situations. The Whole Numbers strand is divided into three topics: Place Value, Operations, and Theory of Numbers. The organization of the items by topic is shown in Table 5-6.

Table 5-6.
Grade 7:
Whole Numbers.

	Topic	Number of Items	Mean Percent Correct	Number of Items Meeting Expectations
1.1	Place Value	5	72	4
1.2	Operations	6	74	5
1.3	Theory of Numbers	6	42	2
Total		17	62	11

Topic 1.1: Place Value

The place value topic consisted of five items. Student achievement on two of the five items either met or exceeded the Interpretation Panel's expected level of performance and two of the items met the Panel's desired level of performance. Item A02, shown below, is typical of items in this topic. It is also a change item, that is, an item which appeared on the 1985 Assessment. Items are identified by the number on the form on which they appeared. Therefore Item A02 is the second item appearing on Form A. The asterisk indicates the correct

Item A02 As of June 1, 1976, the population of Canada was 22 589 416. Round off 22 589 416 to the nearest ten thousand.

		% of students	
A)	22 580 000	5	
B)	23 000 000	8	
C)	22 600 000	10	
D)	22 590 000	75	* (1985 - 69%)
E)	I don't know	2	

response.

The Panel was quite satisfied with student achievement on items in this topic. The only item on which students did not perform up to the Panel's expectations was Item B04 which required students to state the decimal equivalent of a number expressed in expanded notation with exponents.

Topic 1.2: Operations

The six items in this topic required students to add, subtract, multiply, and divide whole numbers and to apply those operations in real life situations.

Item C05 Ms. Brown borrowed $3500 from the bank. She agreed to repay the loan in 36 monthly payments of $180. How much money in total was repaid?

		% of students	
A)	$216	3	
B)	$3680	10	
C)	$37165	5	
D)	$6480	76	*
E)	I don't know	6	

Student performance on five of the six items met or exceeded Panel expectations. Item C05 is an example of these items.

The one item which did not meet the Panel's expectations involved estimating a product of four decimal numbers. This item was repeated on all forms: A05, B05, C07, and D05, and is shown below. The low proportion of students choosing the correct answer and the high proportion of students selecting "I don't know" is surprising given that 90 percent of the teachers indicated on the

Item A05 Estimate the product: 9.75 x 11.134 x 2.9065 x 8.910

		% of students	
A)	3000	52	*
B)	2000	23	
C)	300	8	
D)	200	5	
E)	I don't know	12	

teacher questionnaires that the mathematics required to answer this item had been taught or reviewed during the school year of the assessment.

In general the Panel felt that student performance on whole number operations was reaching their expectations, especially the performance on applications questions, in particular, given that one was in the relatively unfamiliar context of banking and loans. The Panel suggested, however, that more attention be paid to teaching students techniques for estimating.

Topic 1.3: Theory of Numbers

There were six items in the number theory topic. Two of the items required students to evaluate expressions using the rules for order of operations and student achievement on these items did not meet Panel expectations. Only 12 percent of the students correctly answered item A04 which is reproduced below. This performance is consistent with student performance on the 1985 Assessment where only 11 percent of the students answered this item correctly. The Panel was of the opinion that the reason for the poor performance on this item was due to the implied multiplication. If the multiplication sign had been included, they felt that performance would have been better. This opinion was borne out in part by the fact that performance on Item B03 which was more involved and had nested parentheses was answered correctly by 42 percent of the students. Of further interest is the fact that student performance on items requiring students to evaluate algebraic expressions where multiplication is implied in terms such as $3a$, was generally satisfactory. It should also be noted that 86 percent of the teachers indicated that the mathematics needed to answer this item correctly was taught earlier in the school year and that over half of the teachers expected more than 60 percent of the students to answer this item correctly. The Panel

Item A04 The value of $3 + 4(5 + 2)$ is

		% of students	
A)	25	8	
B)	26	5	
C)	31	12	* (1985 - 11%)
D)	49	49	
E)	I don't know	25	

recommended that teachers spend more time on evaluating expressions and the distributive property.

Three of the remaining four number theory items assessed students' knowledge of prime numbers, least common multiple, and greatest common factor. Generally the Panel was of the opinion that number theory is one of the least relevant topics in the curriculum and that it is of little significance. Even so, OTL data suggest that most teachers teach this content and student performance on straightforward items approximated Panel expectations and in one case exceeded expectations.

The last item in this topic, D04, was a problem-solving item involving bacteria population doubling each hour for six hours. Most students chose simply to multiply 6 and 15. Some Panel members commented that if students were taught problem-solving skills such as making a table or list, achievement would have been higher.

Item D04

The number of bacteria in a jar doubles every hour. If there are 15 bacteria in the jar at noon, how many will be in the jar six hour later?

		% of students
A)	156	13
B)	90	43
C)	180	10
D)	960	30 *
E)	I don't know	4

Summary

The Panel felt that performance on the items in the Whole Numbers strand indicated that students understood place value concepts and could calculate with whole numbers and apply operations with whole numbers. Students had some difficulty with estimation and the Panel recommended that teachers emphasize techniques for estimating answers. Student performance did not meet expectations for evaluating an expression involving order of operations. The Panel recommended that teachers spend more time teaching evaluation of expressions and the distributive property.

Strand 2: Rational Numbers

It is intended that, by the end of Grade 7, students will have a grasp of many of the concepts underlying decimal fractions, common fractions, ratio, proportion, and percent and that they will have been introduced to the topic of integers. Students are expected to be able to apply these skills and concepts. Items in the Rational Numbers strand were organized into four topics. Table 5-7 shows this organization.

Table 5-7.
Grade 7:
Rational Numbers.

	Topic	Number of Items	Mean Percent Correct	Number of Items meeting Expectations
2.1	Decimal Fractions	11	60	7
2.2	Common Fractions	12	54	3
2.3	Ratio, Proportion & Percent	14	60	10
2.4	Integers	12	49	4
	Total	49	56	24

Topic 2.1: Decimal Fractions

Items in this topic assessed students' understanding of decimal concepts, their ability to compute with decimal numbers, and their ability to apply computations in real-world settings. Students had some difficulty identifying the largest

decimal number in a set. They also had difficulty converting a decimal to a common fraction in lowest terms. However, if unreduced answers had been accepted, then almost 80 percent of the students answered correctly.

Student performance on a decimal subtraction item and on an item indicating an understanding of the relationship between multiplying and dividing by a power of ten met Panel expectations. Students' achievement on an item requiring multiplication by a power of ten less than one and on an item on decimal division failed to meet expectations. On the other hand, student achievement on three of the four items requiring students to use decimal operations in one-step applications met or exceeded expectations. One application that required decimal division did not meet expectations. Panel members pointed out that students tended to do better on items picturing more re. '-life situations, particularly if money was involved. Item B10, reproduced below, is one such item.

Item B10 There :.re 25 students in Mary's class. The class goes on a field trip to the museum. If tickets cost $2.85 each, what is the total cost of tickets for the class?

		% of students	
A)	$8.77	1	
B)	$19.95	3	
C)	$71.25	90	*
D)	$91.20	3	
E)	I don't know	2	

Panel members felt that overall students were achieving at a reasonable level in topics involving decimal fractions; however, it appears that decimal division requires additional attention. As will be shown later in the chapter, student performance on items in this topic exceeded performance on the 1985 Assessment. This appears to mirror the increased emphasis on decimals in the revised curriculum put in place since the last assessment.

Topic 2.2: Common Fractions

Students responded to 12 items in which they had to reduce fractions to lowest terms, convert a common fraction to a decimal, add, subtract, and multiply fractions, and apply fraction operations. Fraction operations have been deemphasized in the revised curriculum and student performance on items repeated from the 1985 Assessment was slightly below 1985 levels overall.

Student performance fell well below Panel expectations on items involving converting a fraction to a decimal and on identifying the largest fraction in a set. Students did meet expectations on reducing $^{8}/_{12}$ to lowest terms.

Students did not meet Panel expectations on two out of three items involving adding or subtracting simple fractions and mixed numerals. Item C03 is one of those items. Half of the students answered this item correctly, but one-third of them simply added numerators and denominators together. It should be

pointed out, however, that it is unclear from the curriculum guide whether or not such an item is actually covered in the revised curriculum.

Item C03 Add: $\frac{1}{2} + \frac{1}{3}$

		% of students		
A)	2/5	34		
B)	1/5	8		
C)	1/6	5		
D)	5/6	51	*	(1985 - 59%)
E)	I don't know	2		

Note: In the assessment booklets, fractions were printed in vertical format.

Similarly, student performance on four applications items were below Panel expectations. One application involved division and 37 percent of the students answered correctly. Division by a proper fraction is not strictly part of the revised curriculum but over 80 percent of the teachers indicated on the teacher questionnaire that the mathematics needed to answer this item correctly was taught during the school year or a previous year. The three remaining items were two-step applications involving multiplication of fractions and addition or subtraction. Item A09 is typical of these items. In this item, it appears as though almost a third of the students completed the first operation correctly then failed to perform the second operation.

Item A09 John had 12 baseball cards. He gave 1/3 of them to Jim. How many does John have left?

		% of students		
A)	4	29		
B)	6	4		
C)	8	49	*	(1985 - 41%)
D)	9	16		
E)	I don't know	2		

The Panel recognized that fraction operations have been de-emphasized in the revised curriculum but they had expected better performance on most of the items in this topic. Recognizing that teachers are currently in transition between the two curricula, they recommended that teachers take more care teaching fraction concepts.

Topic 2.3: Ratio, Proportion, and Percent

Students responded to 14 items in this topic which assessed students' ability to find equivalent ratios, convert among fractions, decimals, and percent, solve percent exercises, and apply concepts of ratio and percent. Overall students met or exceeded Panel expectations on 10 of the items.

Students showed relatively strong performance on an item requiring them to find an equivalent ratio and another in which they determined an equivalent rate. Three items required students to convert among decimals, common fractions, and percents. Student performance was less than expected on these items. On Item D14, 60 percent selected the correct response. Teachers indicated on the questionnaire that 85 percent of the students had been taught t!㎝ mathematics necessary to answer the question correctly and 70 percent of the teachers predicted a performance of over 60 percent.

Item D14 What is 90% written as a decimal fraction?

		% of students	
A)	0.09	11	
B)	0.9	60	*
C)	9.0	6	
D)	90.0	20	
E)	I don't know	2	

Student performance met expectations on an item on which students had to find a percent of a number and on another where students were asked to identify a 10 percent discount. Half the students could find what percent 13 is of 20. This performance was just at the Panel's expected level. This is consistent with data from the teacher questionnaire where over half of the teachers expected a performance less than 60 percent and less than two-thirds indicated that students had been taught the mathematics necessary to answer the question correctly.

On the other hand, students appear to have a good grasp of the concept of more and less than 100 percent. Sixty-four percent answered Item B15 correctly, more students than the Panel had expected to answer correctly.

Item B15 The number *a* is larger than the number *b*. Therefore

		% of students	
A)	*a* is less than 1% of *b*	6	
B)	*a* is less than 100% of *b*	6	
C)	*a* is exactly 100% of *b*	8	
D)	*a* is more than 100% of *b*	64	*
E)	I don't know	17	

Five items on this topic were applications of proportion and percent. Student achievement on three of the items met Panel expectations. One of these items, A12 is shown below. This is a relatively difficult ratio problem requiring two steps. Student performance just matched Panel expectations. The Panel's desired level would have been reached if some students had not neglected to perform the second step in the problem. These students chose the second distractor.

Item A12 A machine seals 225 boxes in 3 hours. There are 1000 boxes to seal. How many will be left unsealed after an 8-hour shift?

		% of students	
A)	400	50	*
B)	600	23	
C)	800	9	
D)	925	6	
E)	I don't know.	11	

Student achievement on the fourth item, 78 percent correct, exceeded both the expected and desired levels of performance as well as 1985 performance. In this item, students were required to find the scale distance on a map given the scale and the actual distance. In the fifth item students were given the ratio of girls to boys and the total number of persons. They then had to determine the number of girls. Only 36 percent of the students were able to answer correctly. Data from the teacher questionnaire shows that 70 percent of the students had been taught the mathematics necessary to answer the question correctly and three-quarters of the teachers expected a performance level greater than that attained.

The Panel was pleased with student achievement on the items in this topic although it is clear that the relationships among common fractions, decimals, and percents need to be emphasized more.

Topic 2.4: Integers

Integers is a new topic for Grade 7 according to the revised curriculum. Data from the teacher questionnaire indicate that for over half of the students this topic was not taught prior to the assessment. The Interpretation Panel also pointed out that at least one of the prescribed texts does not cover integer operations and that the supplemental material required may not be used by all teachers. Given these factors, the relatively low student performance on many items, particularly those involving computation with integers, is not surprising.

Students performed at the Interpretation Panel's expected level in identifying an opposite and comparing the size of zero with any negative number. Students did not perform at the expected level on items that required them to identify the proper use of a negative number in describing a physical situation, to compare temperatures, or to place a negative integer on the number line.

With regard to integer operations, two-thirds of the students correctly added (-6) + 4 but less than a quarter of the students were able to correctly answer simple integer multiplication or division questions. Surprisingly, student performance on applications involving integers exceeded that on simple computations. Item B18 is typical of the three applications items. Almost half of the students answered this item correctly. This was lower than Panel expectations but double the performance on the multiplication and division items.

Item B18 The temperature went from 5°C to -7°C over a period of 2 days. What was the average temperature change per day?

		% of students	
A)	-6 degrees	45	*
B)	-1 degree	16	
C)	1 degree	17	
D)	12 degrees	15	
E)	I don't know.	6	

The Panel recommended that integers be taught earlier in the year and that teachers make use of supplementary materials if the topic is not adequately covered in the text series used. They also suggested that integers be taught with reference to real-life situations as much as possible.

Summary

The Interpretation Panel felt that student achievement on decimals, common fractions, and ratio, proportion, and percent was satisfactory but that achievement in integers was below expectations. Within each topic they had some specific recommendations. In particular, the Panel felt that decimal division requires additional attention as do fraction concepts and the relationship among fraction, decimal, and percent forms of rational numbers.

Poor performance on integer items may be due to the fact that many teachers had not taught integers prior to the assessment in May. It also appears from the teacher questionnaire data that a sizable proportion of teachers, approximately a quarter, feel that integer muitiplication and division is a topic for later grades. The Panel recommended that teachers ensure that they teach integers and make use of supplementary materials if the topic is not adequately covered in the text series that they use.

Strand 3: Data Analysis

Data Analysis is a strand that has been given increased emphasis in the recent curriculum revision. By the end of elementary school students should be able to collect data from both primary and secondary sources, organize the data into tables charts, and graphs, recognize bias, and discuss the use and misuse of statistical information. Students should be able to classify data, interpret and discuss the reasonableness of results, solve problems with tables and graphs, and solve problems involving simple statistical notions such as mean, median, and mode. Students are also expected to have a grasp of simple probability concepts. The 17 items in the strand were organized into three topics which reflect those specified in the *Mathematics 1-8 Curriculum Guide* (1987). Table 5-8 shows the organization of items by topic.

Table 5-8.
Grade 7: Strand 3 Data Analysis.

Topic		Number of Items	Mean Percent Correct	Number of Items meeting Expectations
3.1	Collecting data	5	66	2
3.2	Organizing & displaying data	6	47	3
3.3	Interpreting data	6	52	4
	Total	17	54	9

Topic 3.1: Collecting Data

In this topic students responded to items dealing with data collection by probability experiment and questionnaire, recognition of the difference between a population and a sample, and recognition of bias in data collection. Student performance met Panel expectations on an item for which one had to choose the most appropriate spinner to conduct a probability experiment and on an item for which students had to identify which population a sample represented. Student performance was less than expected on two items regarding the construction of a questionnaire. Item C22 which is reproduced below is one of these items. Students also did not perform as well as expected on an item involving a discussion of bias in a sample.

Item C22 You are designing a questionnaire to determine the kinds of pets that Grade 7 students have at home. Which set of questions is most appropriate to ask children outside a movie theatre?

		% of students	
A)	What grade are you in? What pets do you have?	67	*
B)	Do you have a dog? Do you have a cat?	11	
C)	How old are you? What animals do you like best?	14	
D)	What pets do you own? Are you a boy or a girl?	5	
E)	I don't know.	2	

The Panel felt that student achievement was satisfactory overall, given the complexity of the questions asked. It also appears from the teacher questionnaire data that half of the students had not yet studied this material in class.

Topic 3.2: Organizing and Displaying Data

The six items in this topic assessed students' ability to construct a frequency table, a bar graph, and a stem-and-leaf plot and to predict the outcomes of a probability experiment. Student achievement reached Panel expectations on the bar graph item and fell well short of expectations on constructing a table and a stem-and-leaf plot. On the stem-and-leaf plot item, D23, shown below, 42 percent of the students chose "I don't know". This is in line with the data gathered

from teacher questionnaires that show that 28 percent of the teachers believe that this topic belongs in a subsequent year and a further 35 percent believe that it will not be taught at all.

Item D23 Here is a stem-and-leaf plot of scores on a mathematics test. Which list of scores matches the stem-and-leaf plot?

5	3
6	1 5 7
7	2 4 8
8	2 4 8
9	1

		% of students	
A)	1, 1, 2, 3, 3, 5, 5, 7, 8	6	
B)	1, 1, 2, 3, 3, 4, 5, 5, 5, 6, 7, 7, 8, 8, 9	12	
C)	53, 61, 57, 72, 48, 83, 85, 91	14	
D)	53, 61, 65, 67, 72, 74, 78, 82, 84, 88, 91	26	*
E)	I don't know	42	

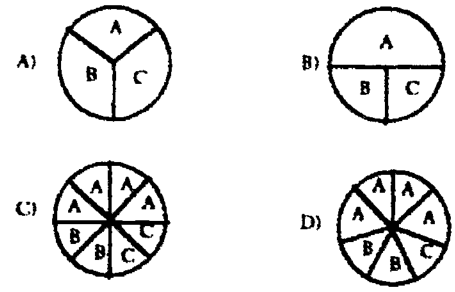
Students' performance on an item on which it was necessary to state all the possible outcomes of the toss of two dice and on another item about the probability of choosing a given ball from a bowl was below Panel expectations. This poor performance may be explained by the fact that 40 percent of the teachers claimed that this material would be covered later in the school year. A further 33 percent said that the material would be taught in a later grade or not at all. The Panel stated that the mathematics necessary to complete the probability item does not appear in one of the prescribed texts but rather in supplementary material.

On the other hand, performance was up to Panel expectations on an item where students had to choose the spinner that would produce a given table of data. This item, C23, is shown below and is repeated from the 1985 Assessment. The proportion of students choosing the correct answer was almost identical in the two assessments.

Item C23 Sparky Spencer spun a spinner 100 times and made a record of his results.

Outcome	A	B	C
Number of times	55	30	15

Which spinner did he most likely use?



% of students		
A)	12	
B)	9	
C)	14	
D)	57	* (1985 - 56%)
E)	7	

E) I don't know.

The Panel felt that more time was needed to be devoted to the topic of organizing and displaying data. In particular teachers should recognize that material not found in the text series should still be covered in supplementary material. The Panel was also mindful of the fact that Data Analysis is a new topic in the curriculum and that some time will probably be necessary for teachers to make a transition from the old curriculum.

Topic 3.3: Interpreting Data

Three of the six items on this topic required students to interpret graphs and the other three dealt with the notions of mean, median, and mode. Students achieved at or above Panel expectations on the graph questions, even on a graph where students had to read rainfall for two months from a combination bar and line graph and then give the difference in the two rainfall figures.

On the three items involving mean, median, and mode, however, student achievement was well below expectations. The mode item, B22, is reproduced below. In this item a quarter of the students chose "I don't know". On the mean item only 26 percent of the students correctly took the mean of 5 prices of sweaters given. The Panel remarked that it was clear that students do not understand the meaning of "mean" nor do they understand what "mode" is. In the final item, assessing the meaning of the term median, although more than half of the students selected the correct answer, the Panel remarked that it is possible that the same results would have been obtained if any of the terms mean, median, or mode had been used as students may interpret any of those terms to mean "half way".

Item B22 The tally chart below shows the finishing times for the first 18 runners in the 5.0 km run. What is the mode of the finishing times?

Time	Tally
17 min	II
18 min	III
19 min	I
20 min	I
21 min	I
22 min	II
23 min	III
24 min	IIIII

		% of students	
A)	5 minutes	8	
B)	20 minutes	20	
C)	22 minutes	22	
D)	24 minutes	34	*
E)	I don't know	25	

Summary

It appears from both the student data and the responses to the teacher questionnaires that Data Analysis content is either left until the end of the year or not covered at all. The Panel was pleased with student performance on collecting data, but more time needs to be devoted to organizing and displaying data. Students can interpret data from tables and graphs but do not achieve at expected levels when dealing with mean, median, and mode. The Panel felt that one way to improve student achievement in the Data Analysis strand would be for teachers to make a conscious effort to integrate Data Analysis concepts throughout the curriculum and to use the terms mean, median, and mode consistently throughout. Teachers also need to be aware that some material such as stem-and-leaf plots may need to be covered using supplementary material if the text used does not contain it.

Strand 4: Geometry

Geometry is another strand which has received increased emphasis in the recent curriculum revision. Elements of transformational geometry are much more prominent. The items in the Geometry strand show this emphasis.

Students in Grade 7 are expected to be able to classify and to identify figures and parts of figures, both two and three dimensional, to use appropriate vocabulary, and to have an understanding of congruence and similarity. Students are also expected to be able to transform figures by translating, reflecting, and rotating and to be able to locate points in the coordinate plane. Table 5-9 shows the organization of items in the Geometry strand.

Table 5-9. Grade 7: Strand 4 Geometry.

	Topic	Number of Items	Mean Percent Correct	Number of Items meeting Expectations
4.1	Properties	9	58	6
4.2	Similarity	9	48	7
4.3	Analytic geometry	5	40	0
	Total	23	50	13

Topic 4.1: Properties

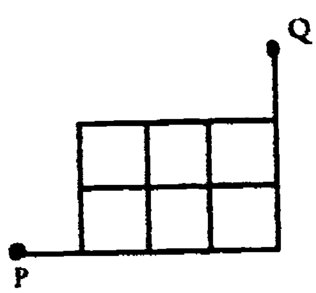
Student achievement was at or above Panel expectations on six of the nine items in this topic: identifying the diameter of a circle, measuring an angle with a protractor, identifying congruent angles and the measures of congruent angles, stating the definition of an equilateral triangle, and stating the number of edges on a cube.

Students had difficulty giving the number of pairs of parallel planes in a right rectangular prism. Only 16 percent of the students gave 3 as the correct answer; 52 percent of the students chose 6, the total number of faces on the prism.

Two problem-solving items were included in this topic. On both items

less than 40 percent of the students chose the correct solution. For Item D30 which is reproduced below, over half of the teachers indicated that the mathematics needed to answer this question correctly had not been taught prior to the assessment. On the other problem-solving item, where students were asked to give the largest number of small squares that could be constructed with 34 toothpicks, the Panel commented that this item may have been too time-consuming for this type of test and that this kind of question was usually assigned as an "enrichment" question. This may indicate that problem-solving strategies are not being taught as a regular part of the mathematics curriculum.

Item D30 A path from P to Q can follow any route as long as it stays on the lines. How many paths from P to Q make exactly 3 turns?



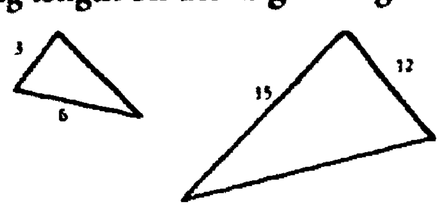
		% of students	
A)	0	16	
B)	3	23	
C)	5	17	
D)	6	36	*
E)	I don't know	8	

Overall the Panel was pleased with student performance on this topic although they suggested that, to improve student knowledge of parallel planes, teachers should use that vocabulary consistently in other areas of the curriculum.

Topic 4.2: Similarity

Two of the nine items in this topic dealt with similar triangles and rectangles, five items with transformational geometry, and one with lines of symmetry. On one of the similarity items, A28 shown below, one-quarter of the students chose "I don't know". On another item where students were asked to give the measure of an angle corresponding to an indicated angle in a similar triangle, 23 percent chose the answer "You cannot tell". It appears that a large proportion of students had not been taught this content prior to the assessment.

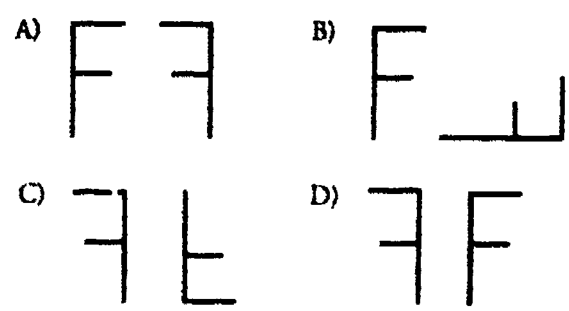
Item A28 The two triangles shown below are similar. What it the missing length on the large triangle?



		% of students	
A)	$3^1/_3$	7	
B)	$7^1/_2$	10	
C)	24	24	*
D)	30	12	
E)	I don't know	25	

Student achievement reached Panel expectations on three of the five items on transformational geometry. However the Panel predicted low performance on these items. Item B30 which is reproduced below is typical of these items. Panel members pointed out that spatial relationships are very difficult for some students and that teachers may not treat transformational geometry seriously as a topic in school mathematics. This last comment is borne out by information from the teacher questionnaire which indicates that 30 percent or more of the teachers would not teach or did not plan to teach the mathematics necessary to answer these items correctly.

Item B30 In which one of the following diagrams is the second figure a rotation of the first?



E) I don't know.

		% of students	
A)	A	21	
B)	B	12	
C)	C	36	*
D)	D	24	
E)	I don't know	6	

On the final item in this topic students were asked to identify the lines of symmetry in a rectangle. Forty-eight percent of the students chose the correct response and another 40 percent chose the figure that showed the lines of symmetry plus the two diagonals. This performance was lower than the Panel had expected.

In summary the Panel thought that students performed well but that their achievement was hindered by the fact that concepts of similarity and transformational geometry are given a low priority by many teachers. The Panel felt that some teachers may feel uncomfortable with the topic and that it is not considered important even though facility in geometry is valuable for other areas of the curriculum and for many careers. They also felt that in order to teach transformations effectively manipulative materials should be used.

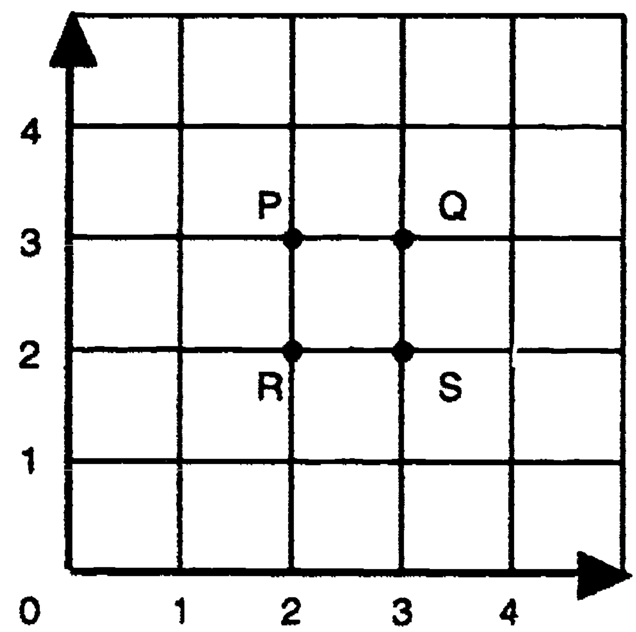
Topic 4.3: Analytic Geometry

Four of the five items in this topic required students to locate points in the first quadrant of the coordinate plane. One of these items also required that students predict the next point following in a pattern. On the fifth item students

had to describe with coordinates the result of a transformation.

Student performance on all items was lower than Panel expectations. A large proportion of students reversed the order of the coordinates. Item A30 is typical of the items and is reproduced below. Forty-six percent of the students chose the correct response and 34 percent chose the response associated with the coordinates in reverse order. On the questionnaire 52 percent of the teachers said that they had taught this content during the school year and a further 34 percent were planning to teach it later in the year.

Item A30 Which point has the coordinates (2,3)?



		% of students	
A)	P	46	*
B)	Q	4	
C)	R	9	
D)	S	34	
E)	I don't know	7	

On the transformation item, students were asked to predict the coordinates of a point after it had been flipped over a vertical line and then slid up two places. Thirty-six percent of the students selected the correct response and 21 percent of the students chose "I don't know". Information from the teacher questionnaire indicates that 38 percent of the teachers had not taught the mathematics necessary for students to answer correctly and a further 33 percent indicated that the material would not be covered in the school year. The poor result is therefore not surprising.

Summary

In summary, the Panel felt that the Geometry strand needed more emphasis by teachers and, as much as possible, geometry vocabulary and concepts should be integrated with other curriculum. Transformational geometry needs specific attention and teachers should be encouraged to teach this topic with manipulative materials. Student confusion over the order of coordinates needs to be addressed. In addition, the Panel felt that there was a need for district-level inservice on geometry.

Strand 5: Measurement

By the end of Grade 7 students should be able to use the SI system of measurement for length, area, volume and capacity, mass, time, and temperature. Students should also be able to apply arithmetic operations to the computation of perimeter, area, and volume and be able to convert from one unit to another. Students should also be able to apply these skills and understandings. Table 5-10 shows the organization of the 16 items in the Measurement strand.

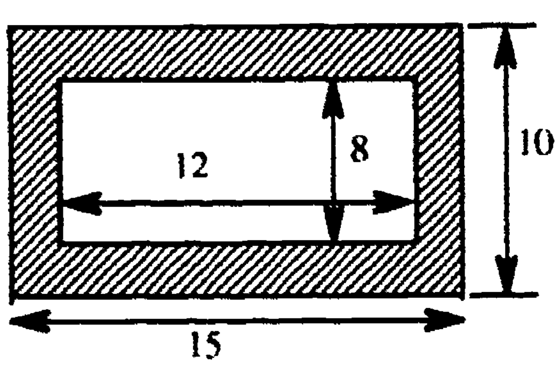
Table 5-10. Grade 7: Strand 5 Measurement.

Topic		Number of Items	Mean Percent Correct	Number of Items meeting Expectations
5.1	Length & area	6	55	2
5.2	Volume & capacity	5	49	2
5.3	Mass	5	45	1
	Total	16	49	5

Topic 5.1: Length and Area

This topic contained six items. Student achievement did not quite meet Panel expectations on the item on which students had to calculate the perimeter of an irregular figure. On two area items student performance was markedly below expectations. Only 35 percent of the students correctly calculated the area of a right triangle; 40 percent chose the distractor which was simply the product of the lengths of the two legs of the triangle; this pattern of responses almost exactly matches that from the 1985 Assessment. On the second area item, B33, reproduced below, 35 percent of the students answered correctly and the pattern of responses matches that of 1985 very closely. The Panel pointed out that this item is two-step application. Although students may know the formula for the area of a rectangle, students are unable to apply it in a situation that involves more than

Item B33 What is the area of the shaded portion of this figure?



		% of students
A)	54	35 * (1985 - 30%)
B)	96	28
C)	120	11
D)	60	10
E)	I don't know	14

one step. Data from the teacher questionnaire indicates that well over 80 percent of the teachers have taught the mathematics necessary for students to correctly answer these items although about one-quarter of the teachers expected less than 40 percent of the students to answer the items correctly.

Student achievement did exceed Panel expectation on two estimation items. One item required students to estimate the thickness of a dime and the other required them to estimate the area of a classroom.

The remaining item, A34, which is reproduced below, is a difficult problem-solving item which required students to read carefully, perform arithmetic operations, and convert among metric units of length. Drawing a diagram is a problem-solving strategy that would be of help in this question. Forty-two percent of the students answered this item correctly compared with a Panel expectation of between 55 percent and 60 percent.

Item A34 Daley's Fruit Stand is on the highway 400 m west of Ash Street. Poplar Street is 1.2 km east of Ash Street along the highway. How far is Daley's Fruit Stand from Poplar Street?

		% of students	
A)	401.2 m	19	
B)	520 m	14	
C)	1.6 km	42	*
D)	5.2 km	11	
E)	I don't know	13	

In summary, the Panel indicated that overall student achievement on this topic was satisfactory particularly on the estimation items. Students had difficulty with two-step applications and with computing the area of a triangle.

Topic 5.2: Volume and Capacity

Student performance on items in this topic indicate that students know the formula for the volume of a right rectangular prism and that they understand some basic notions of capacity. However students were unable to apply these in a two-step application. On Item A32, shown below, 39 percent of the students answered correctly. The Panel indicated that there was a great deal of reading in-

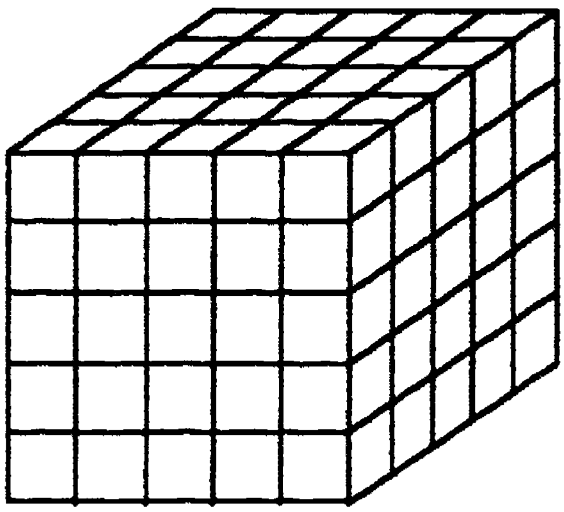
Item A32 The excavation for a swimming pool is a rectangular hole that is 10 m long, 3 m wide, and 3 m deep. A dumptruck can carry 12m^3 of fill. How many truckloads did it take to remove the fill from the excavation?

		% of students	
A)	3	22	
B)	7	18	
C)	8	39	*
D)	12	9	
E)	I don't know	12	

volved in the problem and that some students would not know the meaning of the word excavation.

This topic also contained a problem-solving item, B35, which is shown below. Students were asked to compute the volume of the empty space inside a cube with outside dimensions 5 cm on each edge and walls 1 cm thick. Twenty-nine percent of the students selected the correct answer and a further 26 percent chose the answer that one would obtain by simply taking the cube of 4 cm. Twenty-one percent chose "I don't know".

Item B35 The object below is made up of cubes that are 1 cm on each side. The object is also hollow and the walls are only one cube thick. What is the volume of the empty space inside?



		% of students	
A)	9 cm^3	11	
B)	16 cm^3	11	
C)	27 cm^3	29	*
D)	64 cm^3	26	
E)	I don't know	21	

The Panel felt that the results on the items in this topic showed that students knew the formulas for volume but had difficulty in applying them.

Topic 5.3: Mass

Sixty-eight percent of the students chose a grain of sand as the object having a mass of about a milligram. This exceeded Panel expectations. Only about half of the students could correctly convert 250 g to kilograms, however. This was just under the Panel expectation. Eighty-five percent of the teachers indicated on the questionnaire that the mathematics necessary to answer this item correctly had been taught during the school year and a further 10 percent indicated it had been taught in a previous year.

Two of the remaining three items were applications. On both items student achievement was well below Panel expectations. Less than a third of the students selected 1500 minutes as the greatest length of time compared with 15 000 seconds, 10 hours, and 1 day. Over half the students chose 1 day as the greatest length of time. Panel members commented that this was a poor item because students had to do four computations in order to answer the item.

In the second application, given the mass of one nickel as 5 grams, 28 percent of the students correctly identified the mass of $5.00 in nickels as 0.5 kg. Student responses were evenly distributed among the remaining choices of 1 kg, 5 kg, and 50 kg; five percent chose "I don't know".

The final item in this topic, D34 was a problem-solving item. In explaining the low percentage of students selecting the correct option, the Panel speculated that students may have considered the second hand instead of the minute hand when answering.

Item D34 The minute hand on a clock has made 16 complete revolutions since noon. Approximately what angle does the minute hand make with the hour hand?

		% of students	
A)	30°	15	
B)	60°	18	
C)	90°	29	
D)	120°	23	*
E)	I don't know	14	

Performance on these items indicated students' difficulty with application and problem-solving items. The Panel commented that more work needs to be done with conversion among metric units.

Summary

Overall the Panel was satisfied that student performance was up to expectations on measurement items which involve computing areas of rectangles and rectangular prisms, and on items involving estimation of length, area, and mass. Student performance on problem-solving or applications of more than one step was not up to expectations. The Panel also felt that there needs to be continued emphasis on conversion among metric units and the formula for the area of a triangle.

Strand 6: Algebra

At the Grade 7 level, students are introduced to the ideas of evaluating expressions by substituting whole numbers for variables, writing algebraic equations to describe problem situations, and solving a variety of simple equations. The Algebra strand had 16 items which cover these topics. Table 5-11 shows the organization of the items by topic.

Table 5-11.
Grade 7: Strand 6
Algebra.

Topic		Number of Items	Mean Percent Correct	Number of Items meeting Expectations
6.1	Expressions	8	50	1
6.2	Equations	8	58	4
	Total	16	54	5

Topic 6.1: Expressions

There were eight items on this topic. Two of the items required students to evaluate expressions by substituting whole numbers for variables. Students' achievement on these items, C36 and C37, was 61 percent and 52 percent respectively. This was less than Panel expectations but, given the difficulty that students had in evaluating expressions using order of operations in Topic 1.3, the performance appears reasonable and consistent with what teachers reported as expected achievement on the teacher questionnaire.

Four items required students to write an algebraic expression for a word phrase. Student performance reached the Panel's expectations on one of the items. Item B37 shown below is an example of these items. It should be noted that data from the teacher questionnaires indicate that over a third of the students have not yet been taught the mathematics necessary to answer these items correctly.

Item B37 Which one of the following expressions represents twice a number less 5?

		% of students	
A)	$2x + 10$	4	
B)	$2x - 10$	13	
C)	$2x - 5$	57	*
D)	$2x + 5$	9	
E)	I don't know	15	

In one of the two remaining items, given that x was odd, 35 percent of the students correctly identified $x + 2$ as the next odd number. In item A39 shown on the next page, students were asked to identify the rule given an input-output table. Thirty-five percent of the students selected the correct answer. More than a quarter of them chose "I don't know".

The Panel felt that, because this topic is new in the curriculum and because many teachers may have left Algebra to the end of the school year, students are showing satisfactory performance. The Panel was of the opinion that this topic should be receiving increasing attention.

Item A39 When the input is x, the output is

INPUT	OUTPUT
3	7
4	9
5	11
6	13
7	15
8	17
•	•
•	•
•	•
x	—

		% of students	
A)	19	11	
B)	$2x - 1$	14	
C)	$2x + 1$	35	*
D)	x	13	
E)	I don't know	26	

Topic 6.2: Equations

Four of the eight items in this topic presented students with equations to solve. Student performance fell short of Panel expectations with achievement ranging from 74 percent on the item requiring students to solve $n + 3 = 9$ to 44 percent on the item $x/8 = 16$. Teacher questionnaire data show that about three-quarters of the teachers had taught the mathematics necessary to answer each of these items.

Student achievement, 73 percent, was above Panel expectations on Item C39 which required students to construct an equation. On the other hand only 48 percent of the students were able to correctly translate the phrase "18 more than a number equals 44" into an equation.

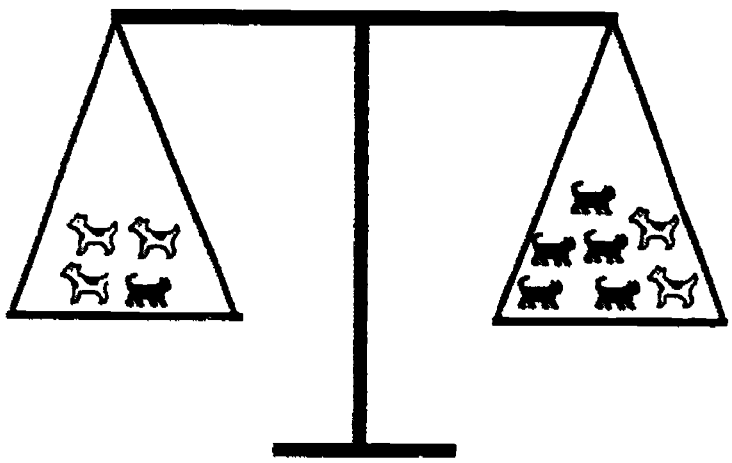
Item C39 Bobby had \$15.00. He spent \$10.80 at the record store and received an amount c as change. Which of the following equations shows the correct relationship among \$15.00, \$10.80, and c.

		% of students	
A)	c - \$15.00 = \$10.80	7	
B)	c + \$15.00 = \$10.80	7	
C)	\$10.80 + \$15.00 = c	6	
D)	\$15.00 - \$10.80 = c	73	*
E)	I don't know	8	

One of the remaining items assessed whether or not students could correctly identify the proper first step for solving the equation $4x = 12$ as dividing both sides of the equation by 4. Student performance of 47 percent was below Panel expectations.

The final item, B40, was a problem-solving item. Forty-eight percent of the students answered the item correctly, and this result met the Panel's expectations.

Item B40 Look at the diagram below. A cat weighs 2 kg. How much does a dog weigh?



		% of students	
A)	4 kg	26	
B)	8 kg	48	*
C)	16 kg	9	
D)	24 kg	5	
E)	I don't know	10	

Student performance met or exceeded Panel expectations on half of the items in this topic. The Panel felt that student achievement will improve as teachers become more familiar with the curriculum and understand the relative emphasis that must be placed on various topics.

Summary

Overall in the Algebra strand student achievement was lower than the Panel's expectations. The Panel felt, however, that student achievement will improve as teachers become more familiar with the curriculum. Data from the teacher questionnaire indicated that a large proportion of students, between 20 percent and 40 percent, had not yet been taught algebra. In addition, as will be seen later in the chapter, student achievement has improved on the algebra items repeated from the 1985 Assessment.

Number Sense

In addition to the 138 items organized into the six strands, the Grade 7 booklets each contained an item designed to assess students' "Number Sense". This may thought of as an ability to deal comfortably with fundamental notions of number and chance, particularly an appreciation of very large and very small numbers and simple probability concepts. For the numerate person this degree of comfort extends beyond his or her ability to perform routine computations and have confidence in the accuracy of his or her results. The numerate person can make reasonable approximations, estimate, and check the reasonableness of re-

sults, particularly as the results apply to situations involving very large or very small numbers.

There were four items in the Number Sense topic. Two items dealt with the concept of a million as a very large number. In one item students were asked to select among a number of alternatives that would be about a million. Just over a third of the students selected the correct response, that is, the number of tennis balls needed to fill a classroom. In a second item students were asked to predict the height of a stack of one million pennies. Almost a quarter of the students chose the answer 2 metres and less than 20 percent chose the correct answer of 2000 metres. Twenty-one percent chose "I don't know."

Less than a third of the students responded that if you divide any positive number by a number greater that 2 then the answer will be less than half of the original number. Twenty two percent of the students claimed that the answer would be impossible to predict. On the final item, 61 percent of the students chose the correct answer for the approximate mass of a horse.

The results of the number sense items indicate that students in Grade 7 do not have a good sense of very large numbers but that for situations that are closer to their experience, such as the mass of a horse, most students can make a reasonable approximation. This result is in line with student performance on items B32, D31, and D32 where students were required to estimate lengths, areas and masses of familiar objects. The Interpretation Panel suggested that more and better items be developed to test students' number sense and that teachers teach more about the concepts of large numbers.

Problem Solving

The assessment booklets contained 9 items which, although organized within topics, were examples of non-routine problems. When faced with these problems it is likely that students would understand the problem and recognize the possibility of a solution but it is unlikely that students would know or be able to apply a routine procedure to solve the problem. The student would then have to use a problem-solving strategy, or heuristic, such as looking for patterns, making a table or organized list, or solving a simpler problem.

Student achievement tended to be quite low on these items with one-half or fewer of the students answering any item correctly. Given the inherent difficulty of the items this is not surprising. It is encouraging, however, to note that more than 10 percent of the students chose the "I don't know" response on only four out of the nine items. This indicates that students appear to be willing to attempt non-routine problems.

OTL data from the teacher questionnaire on three problem-solving items indicate that 70 percent of the teachers taught the mathematics necessary to answer those items. Only one of those items, D30 shown previously, in Topic 4.1 does not make use of content from one of the other curricular strands. Thirty percent of the teachers responded that the mathematics necessary to answer this item had not and would not be taught during the Grade 7 year. Therefore the

prominence of problem-solving strategies is questionable even though the *Curriculum Guide* estimates a time allotment of 12 percent of instructional time in mathematics classrooms.

Changes in Achievement

The 1990 Mathematics Assessment provided an opportunity to examine changes between the achievement of Grade 7 students in 1985 and those in 1990. To measure any changes in achievement eight change categories were constructed. Each category contained no fewer than five items which appeared on both the 1985 and the 1990 Assessments. The change categories and the number of items in each are summarized in Table 5-12.

Table 5-12. Grade 7: Change categories

Change Category	Number of Items	Mean percent correct 1985	Mean percent correct 1990
Whole Numbers	6	66	67
Fractions	6	50	49
Decimals	6	63	67
Ratio, Proportion, & Percent	5	64	66
Measurement	5	47	54
Geometry	5	48	49
Algebra	5	47	54
Statistics	5	55	59
Total	43	55	58

Student achievement was 2.8 percent greater in 1990 on the items repeated from the 1985 Assessment. This result is particularly encouraging in that the student achievement has increased in seven of the eight change categories. Achievement is lower only in the fractions category, an area which has been given less emphasis in the revised curriculum. Some of the improvements are striking. Achievement in the measurement and algebra categories is up by 7 percentage points each and up by four points in the statistics and decimal categories. Algebra, statistics, and decimals are each receiving increased emphasis in the revised curriculum.

Reporting Categories

Students' achievement in mathematics is the result of a great many factors. In a report of this length it is not possible to discuss the relationships among many of these factors, nor is it possible to describe even a very few in depth. In this section student achievement in relation to gender, attitudes, and classroom practices is briefly reviewed. No attempt is made to imply a cause-and-effect relationship; the assessment was not designed for that purpose. It remains for follow-up studies to examine trends and seek these relationships.

Gender Differences

Differences between the sexes in mathematical achievement has been, and continues to be, an area of interest to mathematics educators. Boys' and girls' performances were essentially identical on the entire set of items and differences within strands were less than two percent on all strands except for Measurement, in which the boys outperformed the girls by a margin of four percent. Girls performed slightly better in the Whole Numbers Strand while boys did better in Rational Numbers and Measurement. These trends are in rough agreement with the 1985 Assessment results. The results are summarized in Table 5-13.

Table 5-13. Grade 7: Achievement by strand and gender.

Strand	Boys % correct	Girls % correct
Strand 1: Whole Numbers	60	62
Strand 2: Rational numbers	57	55
Strand 3: Data Analysis	52	53
Strand 4: Geometry	50	49
Strand 5: Measurement	49	45
Strand 6: Algebra	53	54
Total Strands (138 items)	54	54
Total Test (142 items including number sense)	53	53

Students' Attitudes

Across all strands, those students who responded positively to the "Mathematics and Jobs" scale had higher achievement that those students who responded negatively. Similarly, on all forms in each strand, those students who reported topics as important, easy, or enjoyable had higher achievement than students who reported topics as unimportant, difficult, or unenjoyable. The only exception to this rule is that on Form B of the instruments. Students who reported fractions as not important scored as well as students who reported them as important.

Classroom Practices

The assessment instruments gathered information about the frequency of classroom practices as reported by the students. When analyzed according to both achievement within strand and by total test score, the pattern of achievement in each strand by frequency of classroom practice matches the pattern of total test achievement by frequency of classroom practice. Therefore, in this section only total test score is discussed in relation to classroom practices. It should be pointed out, however, that the differences in achievement are less than ten percentage points between any two reporting categories.

There were nine classroom practices on which students were asked to report. The frequency of use of four of these practices is strongly associated with increased achievement, that is, the more frequent the reported practice, the higher

the achievement. These practices are: teacher helping individual students, review of homework, use of blackboard or overhead projector, and students working individually. Over 90 percent of the students reported these activities taking place at least sometimes and over 75 percent reported them as often or almost every day.

Frequency of calculator use and of working in small groups is not associated with a particular trend in achievement. Students did about as well no matter how frequently these activities take place.

Students who reported that quizzes or tests are rarely or never given had lower achievement than students who reported quizzes or tests sometimes, often, or almost every day. Eighty-four percent of the students reported quizzes or tests as sometimes or often compared with 11 percent who report rarely or never.

Very few students, approximately 5 percent, reported use of manipulative materials such as blocks and counters or use of computers as often or every day. These students had lower achievement than other students.

Summary

The 1990 Grade 7 assessment instruments consisted of four student booklets each containing 40 achievement items drawn from a pool of 138 items grouped into eighteen topics in six strands. Six items were repeated on all forms of the student booklets. The booklets also contained fourteen items designed to gather data on student background, attitudes, and classroom practices. All of the achievement items covered topics currently prescribed in the British Columbia mathematics curriculum for Grade 7. An additional four items assessed what was termed as "number sense". Forty-three of the achievement items were repeated from the 1985 Mathematics assessment and provided data with which to compare student achievement between the two Assessments.

Background Information

Ninety-five percent of the students who wrote the Grade 7 assessment were either 12 or 13 years old and almost evenly split between boys and girls with boys slightly outnumbering girls. Ninety-three percent of the students were enrolled in the regular Grade 7 program. Early French Immersion, Late French Immersion, and *Programme-cadre de français* enroll four percent, two and a half percent, and one-half percent respectively. The booklets were translated into French for those students whose mathematics instruction was given in French. About 5 percent of the students responded to the French booklets.

Almost all students agreed that one must be able to do mathematics to get a good job and that most people use mathematics in their jobs. Less than half of the students would like to have a job that requires them to use math. When questioned about various topics in school mathematics, students indicated that although all of the topics listed were important, the traditional topics of basic facts and computation with fractions and decimals were of the greatest importance. Students find learning to use calculators, computation, and estimation as

the easiest topics and learning problem solving strategies, and geometry as the most difficult. These attitudes were consistent with data collected in the 1985 Assessment.

Students' responses to items dealing with classroom practices indicate that most mathematics classes were fairly traditional with time for review of homework, teacher lecture, and individual work with teacher help. Little use of manipulative materials, calculators, or computers was reported.

Achievement Results

The 142 achievement items were distributed almost equally among student forms by strand. The items each had five answer options, the last of which was "I don't know".

Whole Numbers. The Interpretation Panel felt that student performance on the items in the Whole Numbers Strand indicated that students understood place value concepts and could calculate with whole numbers and apply arithmetic operations with whole numbers to real-world situations. Students' performance was not as strong in the Theory of Numbers topic. This may be due to a perception on the part of teachers that this topic is not important. The Panel recommended that teachers spend more time teaching students how to evaluate expressions involving the order of operations, particularly with implied multiplications. Students had difficulty with estimation and the Panel also recommended that teachers emphasize techniques for estimating answers.

Rational Numbers. Student achievement on items in the decimal fractions, common fractions, and ratio, proportion, and percent topics was generally considered reasonable although it appeared that students had difficulty with decimal division and need extra emphasis placed on the relationships among decimal fractions, common fractions, and percents. In addition, the Panel felt that student performance on some Common Fractions items was poorer than it should have been and speculated that this may be due to the fact that fractions are receiving less emphasis in the revised curriculum. The Panel felt that teachers need to take more care in teaching fractions concepts.

Student achievement on the items in the Integers topic was felt to be quite poor. It appeared from data on the teacher questionnaires that a sizable proportion of teachers, approximately one-quarter, did not consider integer multiplication and division to be within the Grade 7 curriculum. This content is not covered in one of the prescribed texts. The Panel strongly recommended that teachers ensure they teach integers and make use of supplementary materials if the content is not adequately covered in the text series they use.

Data Analysis. Data Analysis is receiving increased emphasis in the revised curriculum. Generally the Panel was pleased with students' ability to collect data and to interpret data from tables and graphs. Students did not reach expected levels of performance on items dealing with mean, median, and mode. The Panel suggested that teachers should make an effort to integrate Data Analysis concepts throughout the curriculum and to use the terms mean, median, and

mode consistently throughout. Students did not perform well on items in the Organizing and Displaying Data topic. As with the case of integers, over a quarter of the teachers felt that some data analysis topics are not part of the curriculum and that they are not covered in one of the prescribed texts. The Panel recommended that teachers devote more time to the topic of organizing and displaying data and make use of supplementary materials for content that is not adequately covered in the text.

Geometry. Student achievement on items involving vocabulary and properties of figures was generally satisfactory but students had a great deal of difficulty with items dealing with similarity and transformational geometry. It was the Panel's opinion that transformational geometry was given low priority by many teachers. This opinion was substantiated by data from the teacher questionnaires. On items involving coordinates, many students reversed the order of the number pairs.

In summary, the Panel felt that the Geometry strand needs more emphasis by teachers, that geometry concepts and vocabulary should be integrated into other curriculum areas, that transformational geometry needs specific attention, and that teachers should be encouraged to teach this topic with manipulative materials. The Panel also recommended that districts provide in-service on geometry.

Measurement. Overall student performance in this strand was up to Panel expectations. Students did well on items involving the estimation of length, area, and mass, computing areas of rectangles, and computing the volumes of right rectangular prisms. The Panel felt that there needs to be continued emphasis on conversion among metric units and on the formula for the area of a triangle.

Algebra. Student achievement on most items in the Algebra strand did not meet Panel expectations. Students had difficulty translating a word phrase to algebra and in determining the appropriate rule illustrated in an input-output table. Performance was also generally less than expected on equation-solving items. The Panel felt, however, that student achievement will improve as teachers become more familiar with the curriculum. Data from the teacher questionnaires indicated that a large proportion of students had not yet been taught algebra before the assessment was given.

Number Sense. The student booklets each contained an item designed to assess students' number sense. This may be broadly defined as the ability to deal comfortably with fundamental notions of number and chance including the appreciation of very large and very small numbers. Number sense extends beyond an ability to perform routine computations and have confidence in the accuracy of results to the ability to make reasonable approximations, estimate, and check the reasonableness of results.

The results from the four items indicated that Grade 7 students did not have a very good sense of very large numbers, but that for situations closer to their experience students could make reasonable approximations. The Panel felt

that the items used to assess number sense could be improved and that number sense should continue to be assessed.

Applications. Within each strand there were items which required students to apply concepts and operations to situations that illustrate or approximate real-life situations. Students were found to perform quite well on items that required only a single step. Students had much lower achievement for those items which required more than one step.

Problem-solving. The student booklets contained 9 items which were non-routine problems. To reach solutions for these problems students would not have recourse to a standard procedure or algorithm and would likely have to apply a general problem-solving strategy. These items were difficult and half or fewer of the students answered any one of them correctly. It is encouraging to note, however, that in general few students chose the "I don't know" response. Students appear to be willing to attempt these types of problems but it is probable that problem-solving is being allocated less than the 12 percent of the total instructional time that the *Curriculum Guide* recommends for problem-solving.

Changes in Achievement. Forty-three items from the 1985 Assessment were repeated on the 1990 assessment. These items were grouped into 8 categories. Student achievement was overall 2.8 percentage points higher in 1990 and improved in all of the categories except for the Fractions category. The improvements range from a high of seven percentage points in Measurement and Algebra to one point in Whole Numbers and Geometry.

Reporting Categories. Boys' and girls' performance was essentially identical overall and differences within strands were less than two percent on any strand except Measurement on which boys outperformed girls by four percentage points. Students with positive attitudes towards mathematics had higher achievement than those who do not have positive attitudes.

Frequency of four of the nine classroom practices on which students were asked to report is strongly associated with increased achievement. These practices are: teacher helping individual students, review of homework, use of blackboard or overhead projector, and students working individually. Frequency of calculator use and of working in small groups are not associated with a particular trend in achievement. Students who reported that quizzes or tests are rarely or never given had lower achievement than students who reported quizzes or tests being given sometimes, often, or almost every day. Very few students reported frequent use of manipulative materials or use of computers. These students had lower achievement than other students.

Chapter 6

Grade 10 Results

Alan R. Taylor

Students enrolled in Grade 10 have a choice of two mathematics courses: Mathematics 10 and Mathematics 10A. The two courses are very different from one another, so it would not be reasonable to have both groups of students respond to exactly the same sets of achievement items. For that reason, separate item pools based on the curriculum were developed, and the Grade 10 results are reported here in three categories: common items to which all Grade 10 students responded, items designed specifically for Math 10 students, and items designed for Math 10A students.

The chapter begins with a brief discussion of the instruments which were used. This is followed by a description of the student population and their future plans, and a discussion of students' perceptions of the teaching and learning of mathematics. The next section deals with student achievement, and results are presented separately for each of the three student groups. The chapter includes a discussion of change in achievement over time, results related to gender and type of program, and achievement in the area of problem solving.

Achievement is reported at three levels of aggregation: strand, topic, and achievement category; and the expectations of the Interpretation Panel are included with these results. Their recommendations were arrived at through a process which involved a review of achievement results on the basis of expected and desired levels of performance on each test item. On the basis of these relationships and the personal and professional judgments of its members, the Panel identified results of particular interest.

Description of the Instruments

A total of 240 achievement items was divided among four test booklets, which were distributed randomly within each classroom. Each booklet consisted of 20 common items, 20 Math 10 items, and 20 Math 10A items. All students responded to the common items, and either the set intended for Math 10 or the one for Math 10A. Students were permitted to use calculators when responding to items at the Grade 10 level.

Test items were designed to measure student achievement in five different strands, each divided into two or more topics. The list of strands and topics is shown on the next page. Strands and topics were based on the outcomes for each program as described in the Mathematics Curriculum Guide (Ministry of Education, 1988). The weightings for each strand, by program, are summarized in Figure 6-1 on page 145.

Organization of Achievement Items

Achievement items had five response choices: the correct answer, three plausible but incorrect answers, and the "I don't know" option. Items were either newly developed or else selected from a number of other sources during the spring of 1989. Among the sources used for the selection of items were: the Na-

Strand	Topic
1. Number and Operations	1.1 Whole Numbers 1.2 Rational Numbers 1.3 Irrational Numbers
2. Data Analysis	2.1 Organizing Data 2.2 Interpreting Data 2.3 Probability
3. Geometry	3.1 Properties of Figures 3.2 Right Triangles 3.3 Analytic Geometry 3.4 Trigonometry & Similar Triangles 3.5 Formal Proofs
4. Measurement	4.1 Perimeter 4.2 Area 4.3 Volume
5. Algebra	5.1 Expressions 5.2 Equations

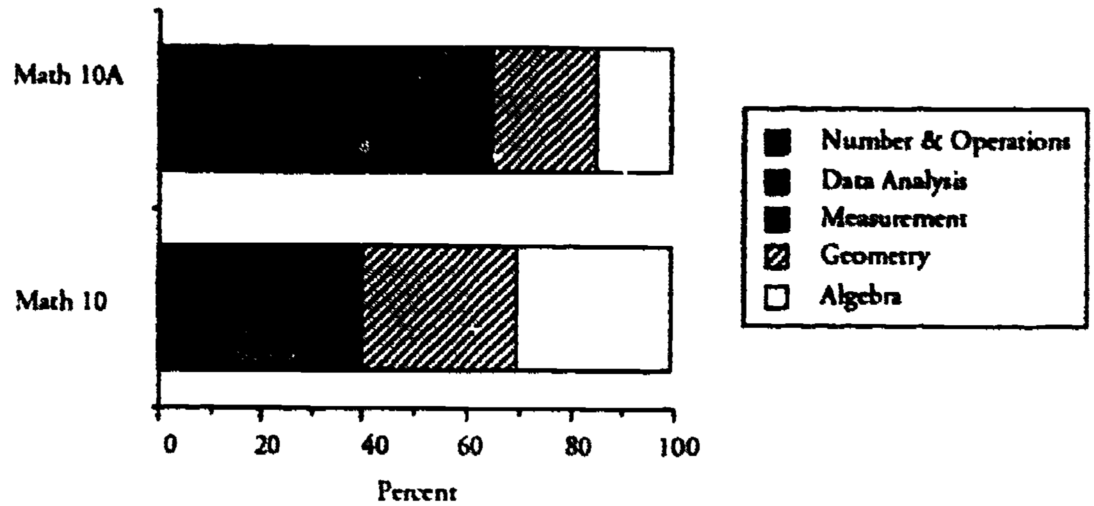
tional Assessment of Educational Progress (NAEP) in the United States, the Second International Mathematics Study, and previous provincial assessments of mathematics in British Columbia. Items from earlier provincial assessments were included to enable some comparisons over time to be made.

The number of items developed or selected in this way was twice as large as those which appeared on the final forms. All items were reviewed by the Advisory Committee at several stages of development. Review Panels were convened in several locations throughout the province during the spring of 1989, and these provided additional input into the content and format of the items. Late in the fall of 1989 these items were pilot tested in a sample of classrooms across the province. Based on earlier reviews, as well as the psychometric properties identified at the pilot stage, approximately half the items were selected to appear on the final forms.

Achievement items within each strand were designed to measure outcomes at three cognitive behavior levels: knowledge, comprehension, and application or problem solving. Test items were distributed equally across forms in an attempt to make them as parallel as possible. This was done by assigning items so that the weightings for topics and cognitive behavior levels were the same for each form. In order to make the forms equal in difficulty, *p*-values of items were estimated on the basis of pilot test results from the previous fall.

The distribution of items by strand is shown in Figure 6-1. The composition for Math 10 and Math 10A is each shown separately.

Figure 6-1. Strand weightings Math 10 and Math 10A.



Thirty percent of the items measured outcomes at each of the knowledge and comprehension levels, with the remaining 40 percent aimed at the application or problem-solving level. Although the proportion of items measuring outcomes at each cognitive behavior level was approximately the same for both courses, some significant differences existed in the respective weightings of strands. For example, more than twice as many items were used to measure Number and Operations in Math 10A as in Math 10: 33 percent compared to 15 percent, respectively. This difference was due to the much greater emphasis placed on this strand in the Math 10A curriculum. On the other hand, the Math 10 curriculum places a greater emphasis on topics in geometry and algebra. As a result, the weightings for these two strands were greater for Math 10 than for Math 10A.

Each booklet included a background section in which students responded to questions related to their backgrounds and future plans, perceptions of the value of mathematics in the workplace and topics in mathematics, and how they learn mathematics in the classroom. Background information involved questions on gender, age, program, and course, whereas information on future plans included which courses students planned to take in Grades 11 and 12 and what they planned to do after leaving secondary school.

A series of three questions dealt with mathematics in the workplace. Students were asked the extent to which they agreed that you have to be able to do mathematics to get a good job, that most people use mathematics in their jobs, and that they would like a job where mathematics is used. A series of questions related to particular topics in mathematics asked students for their perceptions of how important, difficult, and enjoyable they found them to be. In responding to questions related to how they learned mathematics, students reported on the frequency with which the following activities occurred in their classrooms: teacher lectures, small group discussions, teacher working with individuals, individuals working on their own, use of calculators, computers, and concrete materials, discussion of homework, and administration of quizzes and tests.

Description of the Population

All students who were either enrolled in Grade 10 or in a mathematics course at that grade level were required to complete one of the assessment booklets. Those who received mathematics instruction in French wrote a translated version of the booklets. Students in the following categories were excluded: dependently handicapped, moderately mentally handicapped, severely and profoundly handicapped, and autistic. A more detailed discussion of the distribution of test booklets and return rates is contained in Chapter 2.

Gender and Age

Approximately 31 500 booklets were returned. Of these 50.5 percent were completed by males and 49.5 percent by females. The vast majority of students (89 percent) were either 15 or 16 years of age at the time of writing. Results showed that one percent were younger than 15 and ten percent were older than 16.

Program and Course

Students were asked which program they were enrolled in: the regular program in English, French immersion, or *Programme-cadre de français*. Results showed that 96 percent were in the regular program in English, three percent were in French immersion and one percent were in *Programme-cadre de français*. These programs were, for the most part, offered in either a full year (10-month) or a semestered organization. The proportion of students enrolled in each type of organization was as follows: 75 percent in a 10-month program and 23 percent in a semestered one. The balance of students were either not taking a mathematics course in the current year or were enrolled in a mathematics program organized in some other way.

The vast majority of students in Grade 10, 95 percent, were enrolled in either Mathematics 10 or Mathematics 10A at some time during the year. The proportion of Grade 10 students in each course was as follows: Mathematics 10, 70 percent and Mathematics 10A, 25 percent. Of the rest, one percent were enrolled in a mathematics course at the Grade 9 level, two percent in a Grade 11 level course and two percent in a mathematics course not listed among the options provided on the form. These results show that, of those students taking a Grade 10 level mathematics course, slightly more than one quarter were enrolled in Math 10A and almost three quarters were enrolled in Math 10.

Students were asked what made them decide to take the mathematics course they were currently enrolled in. The two most popular responses were that they decided on their own and that it was required for the next mathematics course.

Future Plans

Information on the future plans of students dealt with two main areas: the mathematics courses they planned to take in Grades 11 and 12, and their

plans after leaving secondary school. The question on mathematics courses asked students to mark all options that applied whereas the one on postsecondary plans requested a single response. Results for the question on future courses are shown in Table 6-1.

Table 6-1. Mathematics courses to be taken in Grades 11 and 12.

Course	Percent of Students
Math 11	66
Math 11A	13
Intro Math 11	23
Intro. Accounting 11	11
Math 12	44
Survey Math 12	1
Enriched Math	11

These results show that a significant number of students plan to continue with the study of mathematics into their Grade 12 year. For example, 45 percent selected either Math 12 or Survey Math 12, and 11 percent indicated further study in enriched courses. The fact that 23 percent of students selected Introductory Math 11 indicates that this course may provide a viable pathway leading toward Math 12 for students who are either in the Math 10A program or those in Math 10 who wish to improve their skills before enrolling in Math 11.

Four percent of students indicated that they planned to take either a Grade 10 level course or no course, and 6 percent reported they planned to take a mathematics course not included among the options. The following examples were included with the Enriched Math option: Advanced Placement, International Baccalaureate, and calculus.

The majority of students plan to continue their education after leaving secondary school. Most plan to enter either university, 34 percent, or attend a community college in a university transfer program, 11 percent. Further career-related training was planned by 18 percent who selected options as follows: attend a business school or technical college, six percent; a vocational, art or trade training school, five percent; or a community college in a career program, seven percent. Approximately ten percent plan to take a year off and then either return to school, nine percent, or else look for a job, one percent.

Based on these results, a very high percentage of students plan to continue on with their education immediately after completion of high school or within one year following. For example, 72 percent plan further study: 45 percent university-related; and 27 percent either business or trade-related, or following one year out of school. It is interesting that only four percent have plans to look for a full-time job immediately after completion of high school. Fifteen percent, on the other hand, were undecided.

Mathematics in the Workplace

Three questions dealt with students' perceptions of the importance of mathematics in getting and keeping a job. They asked students if one has to be able to do mathematics to get a good job, if most people use mathematics in their jobs and if they would like a job where mathematics is needed after leaving school. They responded on a five-point scale ranging from "Strongly Disagree" to "Strongly Agree". Results are shown in Table 6-2.

Table 6-2. Mathematics in the workplace.

	Agree	Disagree
You have to be able to do math to get a good job.	75	16
Most people use math in their jobs.	72	14
After completing school, I'd like a job where I have to use math	30	35

The majority of students agreed there was need for mathematics to get a good job, and that math is used in most jobs. For example, 75 percent thought you needed mathematics to get a good job whereas 16 percent felt that it was not necessary. Similar results were found for the second statement where 72 percent felt most people use mathematics in their jobs compared to only 14 percent who disagreed. A significant difference, however, is found in the response pattern for the third statement. Only 30 percent of the students indicated that they would like a job where they had to use mathematics after leaving school while 35 percent indicated that they did not. More than 34 percent, however, were undecided on this statement compared to only nine percent and 14 percent on the first and second statements respectively.

These results show the majority of students recognize that mathematics is needed to get a good job and that most people use mathematics in their jobs. Few students had no opinion on these statements. It is possible, however, that some students may not have been realistic in their ratings for these questions. For example, of those who disagreed to the first two statements, some may have chosen those options based on their opinion of the subject, rather than on its utility in the workplace.

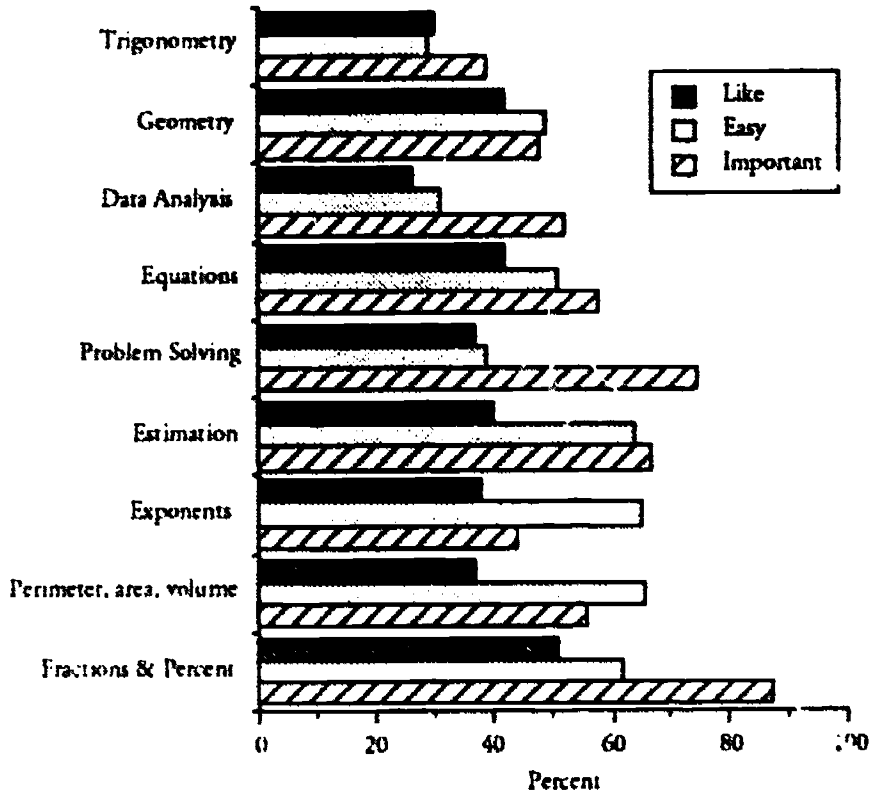
The low rating on the third question appears to contradict results for the first two. For example, if the majority of students agree that mathematics is needed for and used in a good job, it is reasonable to expect that they would like a job where they use mathematics, given they wish to have a good job after leaving school. This result supports the likelihood that attitude toward the subject has an effect on responses to these questions.

Topics in School Mathematics

Previous studies (Robitaille & O'Shea, 1985; Kifer & Robitaille, 1989) have shown that students' opinions about the content of their mathematics course have provided useful insights into the teaching and learning of the subject. Nine topics were selected from the curriculum and students were asked to indi-

cate how important, easy, and enjoyable each was. Results are summarized in Figure 6-2.

Figure 6-2. Mathematics in school: Opinions about topics in mathematics.



Students considered fractions, decimals, and percent to be the most important topic with 87 percent rating it as either important or very important. Other topics with high importance ratings were problem solving, 75 percent, and estimating answers, 67 percent. The lowest importance rating was assigned to trigonometry with a rating of only 39 percent. This was closely followed by working with exponents at 44 percent, and geometry at 48 percent. These results show that students in Grade 10 consider only arithmetic and problem solving to be highly important topics.

Area, perimeter, and volume; working with exponents; estimating answers; and fractions, decimals and percent were rated as the easiest topics. On the other hand, trigonometry, data analysis, and problem solving were considered the most difficult. It is of interest that although students found problem solving to be one of the more difficult topics, they had given it a high importance rating. The opposite occurred with the topic on working with exponents, rated as easy but of low importance.

Ratings for enjoyment were less positive than those for either importance or difficulty. For example, the highest rating, which was for fractions, decimals, and percent, was only 51 percent. The lowest ratings, on the other hand, were for data analysis, 26 percent, and trigonometry, 30 percent.

Although ratings for both the enjoyment and easiness of data analysis were low, students did not consider the topic unimportant. For example, only ten percent rated it in this category. Ratings for trigonometry, however, were low

across all three dimensions. These results suggest that students tend to rate familiar topics and those with applications which are obvious to them more highly than topics which are either new or else of a more abstract nature.

Classroom Practices

The recently revised mathematics curriculum includes a number of changes which could affect the way in which teachers organize their classrooms. For example, the focus on problem solving and the recommended use of technological aids likely have had an impact on the activities used by teachers in the teaching-learning process. In order to collect information on this, students responded to nine items that dealt with perceptions of the frequency with which certain activities took place in their classrooms during a typical week.

In responding to these questions, students were provided the following options: "almost every period", "often", "sometimes", "rarely", and "never". Results, shown in Table 6-3, are listed under two categories: "Frequently" and "Seldom". The first category shows the percent of students who selected either "almost every period" or "often" while the second one consists of the combined responses to "rarely" and "never".

Table 6-3. Teaching practices used in mathematics.

Activity	Frequently	Seldom
Homework reviewed and discussed	75	12
Quizzes or tests administered	69	4
Teacher lectures, notes are taken	63	19
Teacher helps individual students	54	18
Students work individually	78	8
Students work in small groups	18	65
Calculators are used	72	9
Computers are used	4	93
Concrete materials are used	5	82

Traditional activities associated with direct instruction continue to occur frequently in mathematics classrooms. For example, students reported that the following activities occur frequently: homework review, quizzes and tests, and teacher lectures. On the other hand, small group work and the use of concrete materials, which can be associated with cooperative learning, seldom occur.

The infrequent use of computers is of particular interest. This may be due to a lack of good software as well as the common practice of establishing computer labs in secondary schools which appear not to be used by mathematics classes very often. These findings may be counterbalanced, however, through the frequent use of calculators. A significant shift has occurred in this area since the last mathematics assessment. For example, in 1985, 64 percent of students reported they seldom used a calculator in school compared to only nine percent in 1990. The current curriculum guide encourages the use of calculators and it appears that many teachers have followed this direction.

Grade 10 Students' Achievement

Acnievement results are reported here for each of three groups: all students, Math 10A students, and Math 10 students. The mean percent correct for items in each topic is shown, in addition to the number of items which met expectations of the Interpretation Panel. Panelists arrived at expectations for students in each of the two courses, but none were determined for combined results from both groups of students.

Strand 1: Number and Operations

This strand was partitioned into three topics: Whole Numbers, Rational Numbers, and Irrational Numbers. All students responded to items measuring whole number and rational number outcomes, whereas only Math 10 students answered questions related to irrational numbers. Results, by topic, for each of the three student categories are shown in Table 6-4.

Table 6-4. Grade 10: Number & Operations.

Topic	Number of Items	Mean Percent Correct	Number of Items Meeting Expectations
Part 1 - All Students			
1.1 Whole Numbers	6	53	n/a
1.2 Rationals	5	67	n/a
Total	11	59	n/a
Part 2 - Math 10A Students			
1.1 Whole Numbers	15	45	6
1.2 Rationals	28	40	4
Total	43	42	10
Part 3 - Math 10 Students			
1.1 Whole Numbers	6	59	3
1.2 Rationals	5	72	2
1.3 Irrationals	6	45	1
Total	17	58	6

Topic 1.1: Whole Numbers

The Whole Numbers topic consisted of six items which were written by all students and an additional nine written only by Math 10A students. Results ranged from a low of 45 percent for Math 10A students to 59 percent for those in Math 10. The combined result on the six common items was 53 percent. Math 10A students met or exceeded expectations on six of the 15 items and Math 10 students attained that level on three of the six items they wrote.

Item A01, which follows, is a typical question from this section, written by all students.

Item A01 Simplify: $30 - 4(8 - 2)$

		% of students			
		All Grade 10	Math 10A	Math 10	
A)	0	2	2	2	
B)	20	8	17	5	
C)	156	33	51	27	
D)	6	53	24	64	*
E)	I don't know.	3	6	2	

While the majority of students in Math 10 selected the correct answer, those in Math 10A did poorly. Based on these results, teachers of Math 10A should spend more time on simplifying numerical expressions which involve removing brackets with negative leading coefficients.

Topic 1.2: Rational Numbers

The topic of Rational Numbers included five common items, and an additional 23 for Math 10A. Results from all students in Grade 10 showed a mean of 67 percent on the common items. This compared with means of 72 percent for Math 10 and 40 percent for Math 10A. The Interpretation Panel's expectations were met or exceeded on four items in Math 10A and two in Math 10.

A typical item from this topic, which was common, follows.

Item C04 Wendy bought 3 record albums on sale. The regular price was \$7.24 each and the sale price was \$1.50 off each record. If she paid 69¢ sales tax on her total purchase, how much money did she spend?

		% of students			
		All Grade 10	Math 10A	Math 10	
A)	\$17.22	6	10	5	
B)	\$17.91	79	67	83	*
C)	\$21.72	5	9	4	
D)	\$22.91	4	6	3	
E)	I don't know.	5	8	4	

This item was done well by all students and results from both groups were higher than expected by the Interpretation Panel. Math 10A students, however, experienced difficulty with other items on this topic which involved scientific notation and mixed number fractions. On the other hand, they did relatively well on business-related questions involving percent, when they were restricted to whole numbers.

Topic 1.3: Irrational Numbers

This topic consisted of six items, written only by Math 10 students. The mean percent correct was 45 and results met or exceeded expectations of the Interpretation Panel on only one item. These items involved operations with numerical expressions under the radical sign. A typical example, which appeared as Item C41, is shown below.

Item C41 Find the sum in simplest radical form.

$$\sqrt{12} + \sqrt{27}$$

		% of students			
		All Grade 10	Math 10A	Math 10	
A)	$5\sqrt{3}$	–	–	48	*
B)	$\sqrt{39}$	–	–	31	
C)	15	–	–	4	
D)	$3\sqrt{6}$	–	–	8	
E)	I don't know.	–	–	9	

Only 48 percent of students answered this item correctly, relatively poor by the standards of the Interpretation Panel. One reason why results were lower than expected on this set of items is that some teachers had not taught the material. For example, the opportunity to learn results submitted by teachers showed that 19 percent had not taught the content needed to answer this question and did not plan to during the current year. Yet this material is part of the curriculum.

Summary

The mean score for items written by all students in the Number and Operations strand was 59 percent. For items written only by Math 10A students the mean score was 42 percent, and 58 percent for those written only by students in Math 10. Overall, Math 10A students met the Panel's expectations on ten out of 43 items while those in Math 10 attained this level on six out of 17.

For the most part, students did well on items which involved consumer applications, order of operations and simplifying numerical expressions with positive integer exponents. Difficulty was experienced by many, however, in answering items which involved simplification of numerical expressions with negative integer exponents and on those which required recognition and extension of a numerical pattern. Math 10A students, in particular, did not do well on items involving fractions and mixed numbers, and those involving scientific notation. Students in Math 10 found similar difficulty with items which dealt with numbers under a radical sign.

Strand 2: Data Analysis

Data Analysis as a separate strand is new in the recently revised mathematics curriculum in British Columbia. As a result, student achievement and opportunity to learn information from teachers is of particular interest. The strand

was divided into three topics: Organizing Data, Interpretation of Data, and Probability. A total of 29 items, seven of which were common, were administered to the two groups. Results are summarized in Table 6-5.

Table 6-5. Grade 10: Data Analysis.

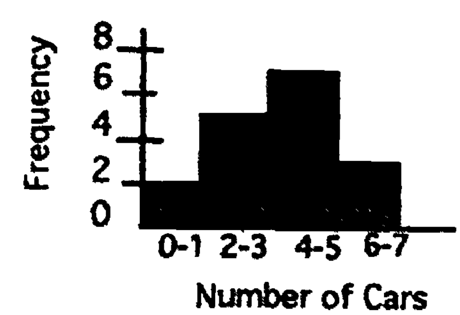
Topic	Number of Items	Mean Percent Correct	Number of Items Meeting Expectations
Part 1 - All Students			
2.2 Interpret Data	4	51	n/a
2.3 Probability	3	39	n/a
Total	7	46	n/a
Part 2 - Math 10A Students			
2.1 Organize Data	3	70	1
2.2 Interpret Data	11	45	4
2.3 Probability	3	27	2
Total	17	46	7
Part 3 - Math 10 Students			
2.2 Interpret Data	8	63	3
2.3 Probability	4	49	1
Total	12	58	4

Topic 2.1: Organizing Data

This topic consisted of three items, administered only to the Math 10A group. As shown in Table 6-5, the mean percent correct was 70 and performance on one of the items met or exceeded expectations of the Panel. Item C30, shown below, is illustrative of this topic.

Item C30 A table and a graph of the same data are shown below. What is the value of x?

Number of Cars	Frequency
0 or 1	2
2 or 3	x
4 or 5	7
6 or 7	3



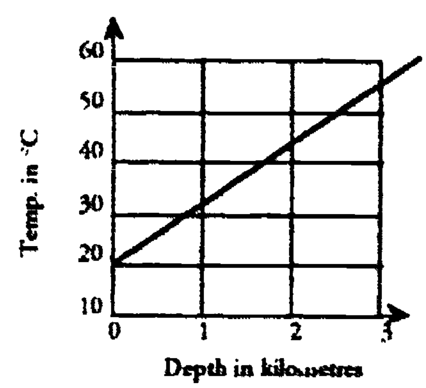
		% of students			
		All Grade 10	Math 10A	Math 10	
A)	3	–	5	–	
B)	4	–	10	–	
C)	5	–	72	–	*
D)	6	–	5	–	
E)	I don't know.	–	6	–	

Math 10A students did well on this item, with a correct response rate of 72 percent. This result illustrates that the majority of students are able to organize and read data which are presented in more than one format. Based on information from the opportunity to learn ratings, the content needed to answer this question is taught by the vast majority of teachers. For example, 91 percent indicated that this material had already been taught and eight percent claimed it would be taught later in the current year.

Topic 2.2: Interpretation of Data

This topic consisted of 19 items, four of which were common. Results for all students on the common items showed a mean percent correct of 51. Math 10A students scored an average of 45 percent on 11 items in this topic whereas those in Math 10 had a mean percent correct of 63. Students met or exceeded the Panel's expectations on four items in Math 10A and three items in Math 10. Item C06, shown below, is an example of a question which was done well.

Item C06 From the graph below, the temperature at a depth of 2.5 km is closest to



		% of students			
		All Grade 10	Math 10A	Math 10	
A)	30°C	3	6	2	
B)	40°C	5	8	4	
C)	50°C	88	78	91	*
D)	60°C	2	5	1	
E)	I don't know.	2	3	1	

These results, which show that the majority of students are able to read a two-dimensional graph, are particularly interesting when compared to the opportunity to learn information. For example, 22 percent of the teachers reported that they planned to teach the content needed to answer this question later in the year and 36 percent did not plan to teach it at all. Although students did well on the question, responses from teachers give cause for concern since the mathematics needed to answer this question is contained in the curriculum.

Topic 2.3: Probability

Math 10A students responded to three probability items and those in Math 10 answered four. Three items were common to both groups. The information in Table 6-5 shows that the mean percent correct for all Grade 10 students was only 39. Math 10A scored 27 percent and the Math 10 result was 49 percent. These results are poor when compared to those for other topics. The highest results were on Item A06, shown below.

Item A06 A bag contains 3 red marbles, 2 white marbles, and 20 black marbles. What is the probability of randomly choosing a white marble?

	% of students			
	All Grade 10	Math 10A	Math 10	
A) 0.08	59	37	67	*
B) 0.5	11	18	8	
C) 0.92	7	12	5	
D) 2.0	9	15	6	
E) I don't know.	14	18	12	

Although this item was the one done best in this topic, results were barely acceptable for Math 10 and poor for Math 10A. This item, which was not done well, tested a straightforward single event, and other questions which involved compound events, were done more poorly. Correct response rates from all students for items in this topic ranged between 15 and 59 percent. This result is not surprising since the opportunity to learn information showed that in many classrooms probability has not been taught. For example, only 42 percent of teachers indicated that the content needed for item A06 had been taught. Twenty-two percent claimed they would teach it later and 36 percent had no plans to teach it. Similar patterns were found for other items in this topic. These results identify a serious shortcoming in implementation of the mathematics curriculum. Although the topic of probability is clearly part of the new curriculum, students do not understand the concept very well and it is not being taught in many mathematics classrooms.

Summary

Overall results for the Data Analysis strand show that the expectations of the Interpretation Panel were met on seven out of 17 items by Math 10A students and on four out of 12 by Math 10 students. Most students were able to read a graph or frequency distribution to determine single values or detect direct relationships. However, they were less successful at using this information to aggregate results or to solve an applied problem. Results on most of the probability questions were not very good. For example, most students in Math 10A could not correctly answer questions which involved either single or compound events. Math 10 students, on the other hand, did relatively well on single-event items but had poor results on those involving compound events.

These findings correspond to results from the opportunity to learn information, in which teachers from a large number of classrooms indicated that much of the mathematics in this strand had not been taught. Probability, in particular, was ignored by many teachers. Poor achievement results and the low priority given to topics in data analysis identify the following needs for this strand: further clarification of content in the mathematics curriculum, more inservice, and the development of additional resource materials.

Strand 3: Geometry

The geometry strand was subdivided into five topics: properties of figures, right triangles, analytic geometry, trigonometry and similar triangles, and proof. Math 10 students responded to questions on all five topics but those in Math 10A were not tested on proof. Common items tested only properties of figures and right triangles. Overall results are shown in Table 6-6.

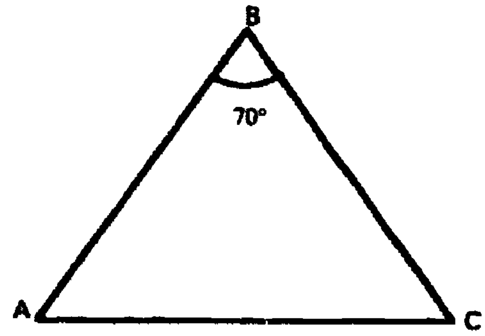
Table 6-6. Grade 10: Geometry.

Topic	Number of Items	Mean Percent Correct	Number of Items Meeting Expectations
Part 1 - All Students			
3.1 Properties	8	55	n/a
3.2 Right Triangles	4	48	n/a
Total	12	53	n/a
Part 2 - Math 10A Students			
3.1 Properties	8	35	1
3.2 Right Triangles	4	28	1
3.3 Analytic Geometry	3	50	0
3.4 Trigonometry	10	23	0
Total	25	31	2
Part 3 - Math 10 Students			
3.1 Properties	8	62	5
3.2 Right Triangles	5	50	1
3.3 Analytic Geometry	11	46	4
3.4 Trigonometry	11	47	6
3.5 Proof	8	61	8
Total	43	53	24

Topic 3.1: Properties of Figures

The topic of properties consisted of eight test items, written by all students. Results were reported three ways: for all students, only Math 10A students, and only Math 10 students. Table 6-6 shows that the mean percent correct for each group was 55, 35, and 62 percent respectively. Math 10A students met or exceeded the Interpretation Panel's expectation on only one of the eight items whereas those in Math 10 either met or surpassed expectations on five. The item which showed the greatest difference in performance between the two groups was B09, which is shown on the next page.

Item B09 The measure of ∠ B is 70°. If AB = CB then the measure of ∠ A is



	% of students			
	All Grade 10	Math 10A	Math 10	
A) 55°	65	26	78	*
B) 60°	4	9	3	
C) 70°	21	43	13	
D) 110°	6	10	4	
E) I don't know.	5	12	2	

Although the mathematics needed to answer this question is contained in the curriculum for both courses, the difference in correct response rates was 52 percentage points. It seems that Math 10A students do not understand the relationship between the equal sides and the base angles of an isosceles triangle. Forty-three percent, for example, selected 70 degrees as the answer. They likely assumed that the triangle was equilateral, even though with this response, the sum of the measures of the interior angles would not be 180 degrees.

Topic 3.2: Right Triangles

This topic included four items written by all students. Results are reported separately for Math 10A, while information for Math 10 includes results from one additional item. The mean for all students was 48 percent. Results for both the Math 10A and the Math 10 groups were disappointing with mean scores of 28 and 50 percent respectively. These performances were both below expectations, and the Interpretation Panel concluded that students did not have an understanding of the Pythagorean Theorem. This is an important observation since this theorem is one of the most important in the geometry strand.

Topic 3.3: Analytic Geometry

Math 10 students responded to 11 items on this topic compared to only three by those in Math 10A. Each of the Math 10A items involved finding the coordinates of a point in the plane and the mean of 50 percent on these, was judged not acceptable by the Interpretation Panel. It had expected a mean of over 80 percent since it considered the questions to be very straightforward. Most Math 10 students answered items involving recognition of the graph of a linear equation correctly. However, they did not do well on items involving systems of linear equations.

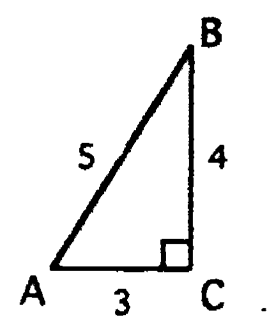
Student achievement on the analytic geometry topic was disappointing. Math 10A students, for example, were unable to demonstrate a sound knowledge of the basic concept of points in the coodinate plane. Students in Math 10, on the other hand, found dealing with systems of equations to be difficult. These results suggest that teachers should give greater emphasis to teaching content in analytic geometry.

Topic 3.4: Trigonometry and Similar Triangles

Results for Math 10 students on trigonometry and similar triangles were based on answers to 11 items. Most involved relationships between properties of similar figures, and several of these tested behaviors at the application and problem solving levels. The mean for this set of items was 47 percent, which was similar to the Interpretation Panel's expectations.

Math 10A students responded to ten different items on this topic. Four involved the relationships between sides of similar triangles, one involved scale diagrams and five dealt with the trigonometric ratios of sides of right triangles. Results were disappointing. Item *p*-values ranged from 17 to 32 with a mean of only 23 percent. These findings suggest that this content is not well taught in many classrooms. A typical item is shown below.

Item D35 The tangent of $\angle A$ in the figure is equal to



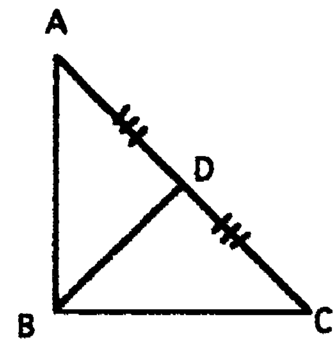
		% of students		
		All Grade 10	Math 10A	Math 10
A)	$4/5$	–	12	–
B)	$5/4$	–	16	–
C)	$3/4$	–	18	–
D)	$4/3$	–	20	– *
E)	I don't know.	–	30	–

Only 20 percent answered this item correctly and teachers reported the following opportunity to learn ratings: 44 percent had taught the material, 41 percent would teach it later in the year and 15 percent did not plan to teach it. Although it is possible that many teachers plan to teach this content near the end of the school year, 41 percent appears high since the assessment was administered in mid-May. If teachers ran out of time it is likely that this content would not be taught at all in many classrooms.

Topic 3.5: Proof

This topic consisted of eight items, administered only to Math 10 students. Results were higher than expected with a mean of 61 percent correct. Students performed at or above the Interpretation Panel's expected level on all eight of the items. Item C51, which follows, is a typical example.

Item C51 In ΔABC, BD is the median to AC. What additional information is required to show that ΔABD is congruent to ΔCBD?



	% of students		
	All Grade 10	Math 10A	Math 10
A) AB = CD	–	–	6
B) AB = BC	–	–	75
C) BD = AB	–	–	6
D) AC = BC	–	–	4
E) I don't know.	–	–	7

Seventy-five percent of the Math 10 students answered this item correctly. This is one of several items in this topic on which students did well. Based on these results formal proof appears to be well taught by teachers of Math 10.

Summary

Students in both Math 10 and Math 10A did well on items involving direct relationships involving vertical and supplementary angles. They found applications of these relationships, however, to be difficult.

Math 10A students did not do well on most other items in this strand. In particular, they did poorly on items which measured trigonometric ratios between sides of right triangles and relationships between corresponding sides of similar figures. On the basis of these findings it is recommended that teachers of Math 10A give greater attention to topics in geometry. It is likely there is need for more in-service and for additional resource material in this area.

Students in Math 10 found some questions involving systems of linear equations difficult, but they did relatively well on straightforward items involving congruent triangles. Formal proof was also done well, while facility with the Pythagorean Theorem was disappointing. These results show areas where students did well and also identify several topics within the geometry strand which require greater attention.

Strand 4: Measurement

The measurement strand was subdivided into three topics: perimeter, area, and volume. Ten items were written by all students, Math 10A students responded to an additional 11, and Math 10 students to an additional two. A summary of results is shown in Table 6-7.

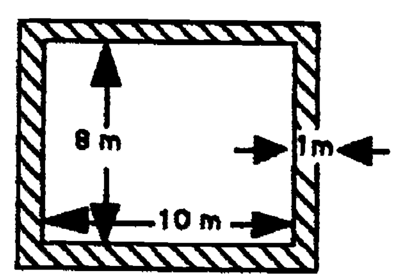
Table 6-7.
Grade 10:
Measurement.

Topic	Number of Items	Mean Percent Correct	Number of Items Meeting Expectations
Part 1 - All Students			
4.1 Perimeter	3	49	n/a
4.2 Area	7	47	n/a
Total	10	48	n/a
Part 2 - Math 10A Students			
4.1 Perimeter	6	34	4
4.2 Area	11	28	2
4.3 Volume	4	34	1
Total	21	31	7
Part 3 - Math 10 Students			
4.1 Perimeter	3	54	3
4.2 Area	7	52	2
4.3 Volume	2	57	1
Total	12	53	6

Topic 4.1: Perimeter

The mean score for all students on the three common items in this topic was 49 percent. Results for Math 10 exceeded the Panel's expectations on all three items. Although overall results for Math 10A were lower than expected, they met or exceeded standards on four of the six items in this topic. Item B13, shown below, proved particularly difficult for students.

Item B13 A rectangular pool is to be surrounded by a rectangular cement walk 1 m wide. If cement costs $2.50 per square metre and the dimensions of the pool are 10 m by 8 m, what would the walk cost?



		% of students			
		All Grade 10	Math 10A	Math 10	
A)	$ 40	12	14	11	
B)	$ 80	16	21	14	
C)	$100	42	27	47	*
D)	$120	15	19	13	
E)	I don't know.	15	17	14	

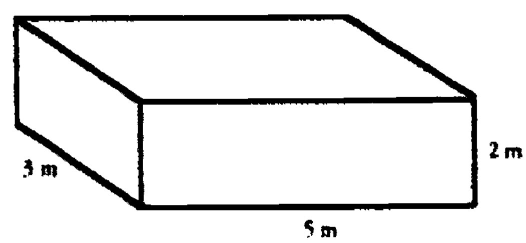
Forty-two percent of all students selected the correct answer for this item, while only 27 percent of Math 10A students answered correctly. Similar results were found with other items in this category. Low achievement on this item may be due to the number of steps involved as well as students' opportunity to learn. For example, 23 percent of the teachers reported that they either had not taught the material yet or else did not plan to teach it during the year.

Topic 4.2: Area

Achievement on this topic was measured by 11 items for Math 10A and seven for Math 10. The items written by Math 10 students were common to both groups. Results showed that students in both groups performed at levels lower than expected by the Interpretation Panel, except for two items.

Differences in achievement between students in Math 10 and Math 10A were particularly large in some items. An example of a large difference in performance between the two groups was shown in Item D15.

Item D15 What is the surface area of the rectangular prism shown below?
Surface Area = $2(lw + lh + wh)$



	% of students			
	All Grade 10	Math 10A	Math 10	
A) $30\ m^2$	11	22	7	
B) $31\ m^2$	10	14	8	
C) $60\ m^2$	10	16	8	
D) $62\ m^2$	61	36	70	*
E) I don't know	8	13	7	

This item tested the ability of students to determine the surface area of a rectangular prism, given the formula. Although 70 percent of Math 10 students answered correctly, only 36 percent in Math 10A selected the correct option. The most frequent error made by students in Math 10A was to calculate volume rather than surface area. Twenty-two percent selected that option.

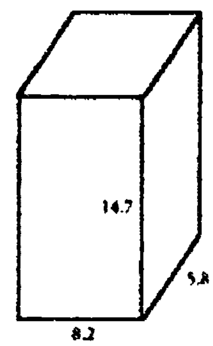
Topic 4.3: Volume

Students in Math 10A responded to four items on this topic. They did better on items which gave the dimensions of a rectangular prism and asked for the volume than on items where the third dimension was unknown, given the volume and two of the dimensions. Some students also found questions which required both estimation and volume to be difficult. Item D16, shown below, is

an example of this.

Item D16

The estimate for the volume of the solid shown below is:



		% of students			
		All Grade 10	Math 10A	Math 10	
A)	29	12	19	9	
B)	56	9	13	8	
C)	550	19	22	18	
D)	720	44	28	50	*
E)	I don't know.	15	16	15	

Only 28 percent of students in Math 10A and 50 percent in Math 10 answered this item correctly. The most frequent incorrect response was 550 (option C). Students selecting this option rounded each dimension down, prior to calculating their product.

Summary

Math 10A students met or exceeded the Interpretation Panel's expectations on seven out of 21 items in the measurement strand. This level of achievement was attained on six out of 12 items by Math 10 students. The correct response rate was rather disappointing with mean percents correct of 31 and 53 by Math 10A and Math 10 students respectively.

Most students were able to determine the perimeter of an isosceles triangle and the surface area of a rectangular prism, given the formula. However, neither group did well on questions involving applications of area and volume. Math 10A students, in particular, found questions involving the perimeter and area of complex figures and circles to be difficult.

Greater emphasis should be given to measurement topics in the curriculum, with particular focus on their applications. Students should be provided with greater opportunity to work on three-dimensional models to gain "hands-on" experience in order to develop their comprehension of spatial relationships.

Strand 5: Algebra

The Algebra strand consisted of two topics: algebraic expressions and equations. Math 10 students responded to a total of 41 items in this strand while

those in Math 10A answered 16, of which ten were common to both groups. Results are summarized in Table 6-8.

Table 6-8. Grade 10: Algebra.

Topic	Number of Items	Mean Percent Correct	Number of Items Meeting Expectations
Part 1 - All Students			
5.1 Expressions	6	59	n/a
5.2 Equations	4	46	n/a
Total	10	54	n/a
Part 2 - Math 10A Students			
5.1 Expressions	10	35	3
5.2 Equations	6	23	0
Total	16	30	3
Part 3 - Math 10 Students			
5.1 Expressions	22	57	11
5.2 Equations	19	46	4
Total	41	52	15

Topic 5.1: Algebraic Expressions

The topic of algebraic expressions consisted of ten items for Math 10A and 22 for Math 10, six of which were common to both groups. Math 10A students met or exceeded expectations of the Interpretation Panel on three items and those in Math 10 attained this level of performance on 11.

Students did relatively well on Item A16, shown below. It is a straightforward item, involving the simplification of an algebraic expression by collecting like terms.

Item A16 Simplify: $7x - 2y - 2x - 4y$

	% of students			
	All Grade 10	Math 10A	Math 10	
A) $-5x - 6y$	7	13	4	
B) $5x - 6y$	83	58	92	*
C) $6y - 5x$	3	7	1	
D) $14x - 8y$	4	10	1	
E) I don't know.	4	12	1	

Eighty-three percent of all students in Grade 10 answered this question correctly, 92 percent in Math 10 and 58 percent in Math 10A. Each of the other options drew similar proportions of responses.

Most students were able to simplify expressions and to find the value of

expressions where coefficients and replacement values were positive. Items involving negative numbers, however, were not well done.

Topic 5.2: Equations

Math 10 students responded to 19 items on this topic compared to six for Math 10A. The overall results on the common items produced a mean of 46 percent. Results for both groups, however, were somewhat disappointing. Math 10A students, for example, had a mean of only 23 percent and their performance did not meet the Interpretation Panel's expectation for any item. Although Math 10 students did better, they were below expectations overall, having met the standard on only four out of 19 items.

Item D19 is a typical application level item from this topic. Students had some difficulty, however, in answering the question correctly.

Item D19 If five is added to a certain number and the sum is multiplied by three, the result is −17. Find the number.

Note: In the assessment booklets, fractions were presented in vertical format.

		% of students			
		All Grade 10	Math 10A	Math 10	
A)	$-2/3$	16	14	17	
B)	4	11	17	8	
C)	$-7\ 1/3$	15	18	14	
D)	$-10\ 2/3$	33	16	40	*
E)	I don't know.	24	34	20	

Results on this item were disappointing, given correct response rates of 16 and 40 percent by students in Math 10A and Math 10 respectively. The high response rate, 20 percent overall, to the "I don't know" option is of particular interest. This result suggests that teachers should give greater emphasis to the translation of word phrases into algebraic statements.

Summary

Overall results for the algebra strand were lower than expected by the Interpretation Panel. For example, students met or exceeded the Panel's expectations on 15 out of 41 items in Math 10 and on only three out of 16 in Math 10A.

Most students were able to simplify algebraic expressions not containing parentheses. However, they did not do well on items measuring this skill when parentheses and negative coefficients were involved. Similar results were found when students were asked to evaluate algebraic expressions by substituting values for variables: they did well when values were positive, but poorly once negative

values were included. Students in Math 10A also had difficulty finding the solution of a linear equation while most in Math 10 were unable to solve a quadratic equation or a linear inequality in one variable.

These results identify some areas for teachers to focus on in teaching and applying algebraic concepts. It is recommended that the items used in this strand be reviewed as exemplars by teachers to assist in gaining direction for course planning and developing supplementary materials.

Number Sense

One additional item contained in each of the four booklets, written by all students in Grade 10, dealt with number sense. This concept involves students' understanding of fundamental notions of number and chance. It requires a conceptual understanding of magnitude and order, basic logic, and the reasonableness of results as they relate to various situations. A student with number sense is considered to be comfortable in dealing with numeric relationships and is able to estimate realistic answers.

A total of four items were included in this category: two dealt with the concept of a million as a large number, the third with an estimate of the weight of a horse, and the fourth with the relationship between factors of a number. These items were also administered at each of Grades 4 and 7.

The item involving one million as a large number dealt with magnitude in two ways. First, students were asked to relate the concept of one million to other sets of numbers and second, they were asked to estimate the height of one million pennies.

In the first question, students were asked which of the following numbers were closest to one million: hairs on your head, grains of sand on a beach, people standing in a soccer field, or tennis balls needed to fill up a classroom. Thirty-four percent selected the correct answer, which was the number of tennis balls needed to fill a classroom. The second question asked students to predict the height of a stack of one million pennies. Only 25 percent selected the correct answer of 2000 metres whereas 30 percent chose "I don't know."

The third question, which asked students the weight of a horse, included the following numbers of kilograms as options: 4, 40, 400, and 4000. Sixty-one percent selected the correct option 400 kg. The "I don't know" option was selected by 15 percent. In the fourth question, students were asked to identify the characteristics of an answer when a positive number was divided by a number greater than two. Forty-seven percent chose the correct response, which was less than half the original number. This question dealt more with a conceptual understanding of the relationships between numbers than the other items, which related more to skill in estimation.

Results show that students in Grade 10 have a better understanding of estimation if it relates to an object of length they are familiar with. For example, the majority were able to estimate the weight of a horse and more than a third

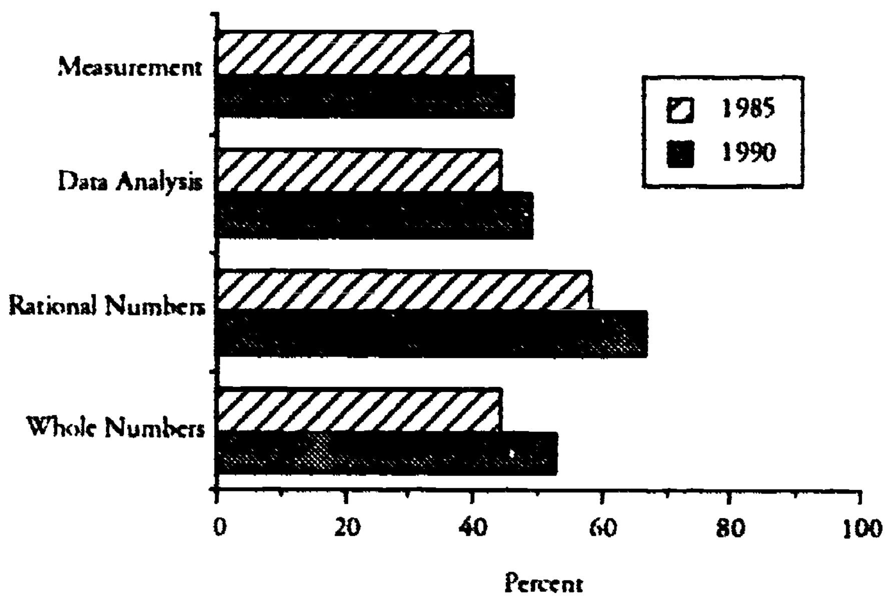
could estimate the number of tennis balls in a classroom. However, only one-quarter could estimate the height of one million pennies, a distance which was not familiar. Based on this information, it is suggested that teachers provide students with more opportunities to examine and explore relationships between numbers and to estimate more often with large numbers.

Changes in Achievement

A number of items administered to Grade 10 students in the 1985 Provincial Mathematics Assessment were repeated in 1990 in order to examine change in achievement over time. Since results in 1985 were for all students in Grade 10, only those repeated items which were written by all students in 1990, were used to compare achievement.

A total of 21 items were examined for differences in achievement: 11 from the number and operation strand, five from data analysis, and five from the measurement strand. The items from number and operation were subdivided into whole number and rational number topics. Results are shown in Figure 6-3.

Figure 6-3. Change in achievement over time.



Improvement was shown in all of the change categories between 1985 and 1990. Differences in means, by reporting category, ranged from five to nine percent with an overall improvement, based on weighted means, of greater than seven percent. A discussion of results for each of the categories follows.

Whole Numbers

As shown in Figure 6-3, differences in achievement on the set of Whole Number items showed the greatest difference, with an overall improvement of nine percentage points. Among individual items in this category, differences ranged from no change to an improvement of 13 percent. The greatest improvement was on item D01.

Item D01 A used automobile can be bought for cash for $2850, or on credit with a down payment of $400 and $80 a month for three years. How much more would a person pay by buying on credit than by buying the car for cash?

	% of students
	All Grade 10
A) $ 3280	12
B) $ 640	7
C) $ 430	68 *
D) $ 400	5
E) I don't know.	8

The improvement of 13 percentage points on this item is likely due, at least in part, to two reasons: changes in the new curriculum and the use of calculators. First, the revised curriculum gives greater emphasis to application and problem solving than the previous one. In the second case, students were permitted the use of calculators for the first time in the 1990 assessment. These changes likely had a positive impact on achievement on all items in this category.

Rational Numbers

Among the five items measuring achievement in operations with rational numbers, gains ranged from four to 13 percent. The greatest gain was on Item A04 which measured students' ability to solve problems involving proportions. Improvement in the level of achievement was likely affected by the reasons stated earlier.

Data Analysis

A considerable variation in performance was found among the five items from the data analysis category. For example, results ranged from a loss of seven percent to a gain of 12 percent. Of the items in this category, four showed a gain and one a loss. The item showing a loss asked students to use information from a chart to solve an applied problem. The greatest gain was on an item involving the mean of a set of numbers.

Measurement

Gains were shown on four out of five items from the measurement category. The item showing a loss dropped only one percentage point compared to gains on the other four ranging from three to 13 percent. The item on which no improvement was shown involved the solution of a multi-step word problem involving area. The greatest gain, on the other hand, was on a word problem involving the volume of a rectangular prism.

Levels of Student Performance

Achievement results were analyzed by the Interpretation Panel in a sec-

ond way, which described the mathematics which students at each of four performance levels could do. Students were divided into four categories according to achievement, where Category 1 was the most basic and Category 4 the most complex. An examination was undertaken of the test items which students in each of the four groups were able to answer correctly. The knowledge and skills reflected by these items were then described by the Interpretation Panel. The four performance levels were hierarchical in nature so that knowledge and skills demonstrated at one level were extended further at a subsequent one. Details related to the establishment of these categories can be found in Chapter 2.

The Interpretation Panel examined the items in each category and characterized student abilities as evidenced by the behaviors needed to respond to them correctly. This was done separately for students in Math 10A and in Math 10. A description of the categories codes follows.

Math 10A Levels of Student Performance

Category 1

Students are able to perform operations and solve consumer-related problems with positive rational numbers. They understand averages and interpret frequency tables, line, and bar graphs. They combine similar terms in algebraic expressions and can determine coordinates on a Cartesian plane.

Category 2

Students are able to perform operations, evaluate expressions, and estimate solutions to multi-step problems with rational numbers. They solve problems by interpreting tables, line, and bar graphs, and can find the probability of a single event. They solve measurement problems involving angles, plane and solid figures, and the Pythagorean Theorem.

Category 3

Students are able to perform operations with integral exponents, scientific notation, and solve problems involving number patterns, proportions, means and the probability of a multiple event. They can solve triangles using the concept of similarity and trigonometric ratios. They can solve linear equations in one variable and convert word expressions into algebraic form. They are able to solve problems involving area, perimeter, composite figures, and estimation.

Category 4

Students are able to solve problems involving estimation and scientific notation, graphs and probability, complementary and supplementary angles, similar and right triangles, and trigonometric ratios. Students are able to simplify algebraic expressions and solve problems involving area and volume.

Math 10 Levels of Student Performance

Category 1

Using whole numbers, students in this category are able to interpret and read line graphs, solve basic measurement problems given the formula and diagram, solve simple probability problems, and perform basic algebraic operations. They can do multiple-step word problems involving whole numbers, money, and percent. They demonstrate a basic understanding of geometry involving properties of straight lines, triangles, and parallelograms.

Category 2

Students are able to perform operations, evaluate expressions, solve equations and inequalities, simplify and solve radicals, and estimate solutions to multi-step problems with rational numbers. They solve problems by interpreting tables, line, and bar graphs, and can find the probability of a single event. They solve measurement problems involving angles, and plane and solid figures.

Category 3

Students are able to perform all operations on radicals and are able to solve problems in compound probability. They have an understanding of linear equations and can solve problems involving similar and right triangles and transversals. They can find the area of rectangles, parallelograms, and the surface area of a rectangular prism. They can solve and graph inequalities and are able to solve multi-step problems in one variable and recognize when there is no solution.

Category 4

Students are able to interpret scientific notation displayed on a calculator and can recognize a number pattern when given a series of diagrams. Students can extrapolate information from graphs, tables, or lists of data and can solve probability problems involving restrictions. They are able to use algebraic skills to solve geometry problems and are able to solve multi-step quadratic equations. They are able to use the coordinate system in the Cartesian plane, the Pythagorean theorem, and use the basic trigonometric functions to solve right triangular problems. They can find the perimeter of composite figures involving circles and triangles and can use estimation skills for determining area.

Correlates of Achievement

Further examination of information about students' achievement and attitudes was undertaken to determine if there were differences in performance levels associated with the following variables: school organization, gender, and classroom practices. Although the findings do not establish causal relationships, they do provide descriptive results associated with each reporting category.

School Organization

Students were asked if the mathematics course they were most recently enrolled in was organized as a ten-month program; semestered, beginning in September; semestered, beginning in January or February; or organized in some other way. As reported earlier, 75 percent were enrolled in a 10-month program and 23 percent in a semestered one.

Further analysis was undertaken to examine the achievement of students in each type of school organization. Results for all students in Grade 10 are summarized in Table 6-9.

Table 6-9. Achievement by course organization (percent).

Type of Organization	Mean
10-Month	50
Semester 1 (September)	45
Semester 2 (January or February)	48

Results show that students enrolled in a full-year program achieved a higher mean score than those in either Semester 1 or Semester 2. There is less difference, however, between the achievement level of students enrolled in Semester 2 and those in a full-year program, than with those enrolled in Semester 1.

These findings could have been affected by a number of factors. For example, students who had taken a semestered mathematics course beginning in September more than likely forgot some of the content which was tested. Those enrolled in a semestered course beginning in January or February, on the other hand, may not have taken some of the content at the time the assessment was administered. It is reasonable to expect that by May, students in full-year programs would have covered a greater portion of the course than those in Semester 2. Given these reasons, differences in achievement, which were not great, cannot be accounted for solely by the type of school organization.

Gender Differences

Comparisons by gender for all students in Grade 10 were examined in the following areas: achievement, attitudes and perceptions, and course enrolments. Achievement results were examined both by strand and higher cognitive level. Further analysis of achievement was undertaken in the area of problem solving because of the emphasis on higher-order thinking skills in the current curriculum and the differences found in this area in earlier assessments (Robitaille & O'Shea, 1985). Information on attitudes and perceptions was available through students' responses to the series of questions on mathematics and the workplace, and on the Mathematics in School scale. Participation rates by gender were examined through the course enrolments in Math 10A and Math 10. Since mathematics is compulsory in British Columbia to the Grade 10 level, overall participation rates by gender were expected to be similar. However, it was of in-

terest to determine which one of the Math 10 and Math 10A courses was chosen by boys and girls. A discussion of the findings follows.

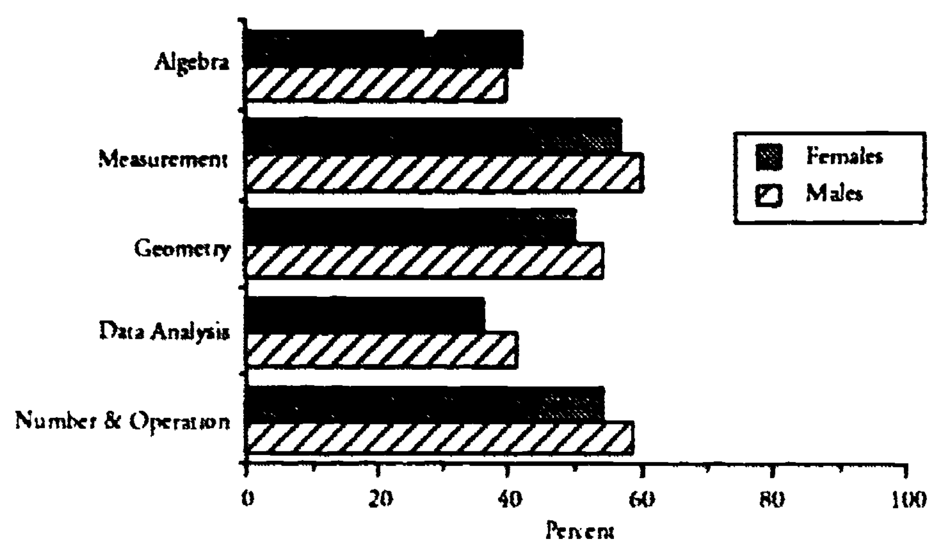
(i) **Achievement Comparisons**

Achievement comparisons were examined for each of the five strands and problem solving. Results by strand were determined by comparing the proportion of items within each of them which were answered correctly by males and females. Information on problem solving, on the other hand, was collected by comparing achievement on items from across stands which measured behaviors at the application or problem-solving level. A discussion of the results follows.

Achievement by Strand: The mean score on each domain was determined separately for males and females. Results for all students are summarized in Figure 6-4.

Boys achieved a higher average score than girls on four strands. For example, algebra was the only reporting category on which girls achieved at a higher level. When results were examined by course, the differences in achievement levels between males and females was greater for Math 10A students than it was for those in Math 10.

Figure 6-4.
Achievement by gender.

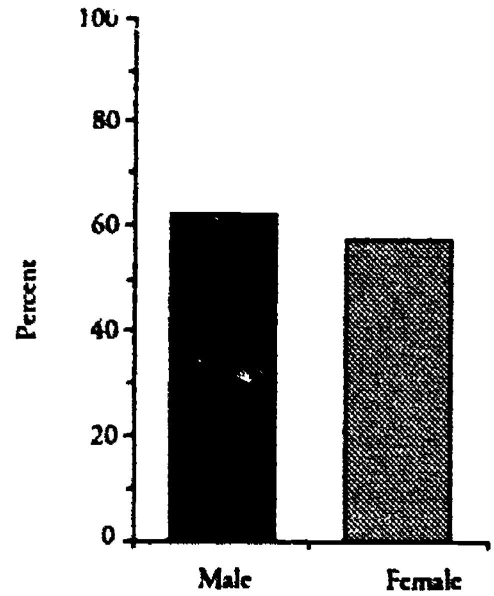


Differences in achievement between genders were not great, but did establish a pattern. As a result of this finding it may be of some interest to identify possible reasons why girls outperformed boys in algebra but did less well on the other strands.

Cognitive Behavior Level: Evidence from the previous mathematics assessment (Robitaille & O'Shea, 1985) showed that boys did better than girls on problem solving. To determine if change in this relationship had occurred, results on items which measured behaviors at either the application or problem-solving level were examined for each gender. A summary is shown in Figure 6-5.

Results in Figure 6-5 show the mean score for males exceeded that for females by five percentage points. Based on this information, it appears that the new curriculum has not had any noticeable effect on differences in achievement

Figure 6-5. Problem solving by gender.



in the area of problem solving between the genders. Some insight into reasons for this finding may be gained through further analysis of relationships between achievement by gender and the following variables: students' and teachers' attitudes, classroom practices, content of resource materials, and the applications of concepts.

(ii) Attitudes and Perceptions

Students responded to two scales which dealt with attitudes or perceptions: one on Mathematics and the Workplace, and the other on Mathematics in School. The first scale consisted of three items in which students were asked to rate the importance of mathematics in getting a good job, the extent to which mathematics is used in jobs, and whether they would like a job in which mathematics is applied. The second scale asked students to rate major topics in the mathematics curriculum in terms of importance, difficultly, and enjoyment. Results for boys and girls were examined separately and a discussion of results follows.

Mathematics and the Workplace. Students responded on a five-point scale ranging from Strongly Agree to Strongly Disagree. Proportions of positive and negative responses were determined and responses analyzed by gender. A summary of results is shown in Table 6-10.

Table 6-10. Mathematics and the workplace: results reported by gender (percent).

Statement	Agree		Disagree	
	Male	Female	Male	Female
You have to be able to do math to get a good job	77	74	15	17
Most people use math in their jobs	71	72	15	13
After completing school I'd like a job where I have to use math	34	26	31	38

Most students agreed that one needs to be able to do mathematics to get a good job and that most people use it in their jobs. Little difference, however, was found between the responses of males and females.

Responses to the third question, which asked students if they would like a job where math is used, were less positive than to the first two. Males, however, responded more positively than females. For example, a positive response was selected by 34 percent of boys compared to 26 percent of the girls. Similarly, a lower proportion of boys responded negatively than girls. This result may indicate that although they recognize the importance of mathematics in the workplace, girls are less confident in their ability to apply it in situations outside of the classroom. It is possible that the type of activities, applications, and problems in the curriculum tend to favor the interests of boys.

Mathematics in School. Perceptions of the importance, difficulty, and enjoyment associated with major topics in mathematics were reported earlier in Figure 6-2. Further analysis of results, however, examined responses by gender. A summary is shown in Table 6-11.

Table 6-11. Students' opinions about topics in mathematics (percent).

Topic	Gender	Important	Easy	Like
Fractions/decimals/percent	Male	84	62	49
	Female	90	62	54
Area/perimeter/volume	Male	60	69	38
	Female	52	64	35
Working with exponents	Male	44	63	35
	Female	43	67	42
Estimating Answers	Male	65	66	41
	Female	68	62	39
Problem Solving	Male	76	43	39
	Female	73	36	36
Equations & expressions	Male	57	48	35
	Female	59	54	48
Data analysis	Male	51	31	25
	Female	54	31	28
Geometry	Male	53	53	45
	Female	42	45	40
Trigonometry	Male	42	30	28
	Female	36	29	30

Similar importance ratings were reported by both genders on five of the topics. Boys rated the importance of the following topics considerably higher than girls: area, perimeter, and volume; geometry; and trigonometry. On the other hand, girls rated fractions, decimals, and percent more highly. These results show that boys rated topics which are more abstract and less familiar, higher in importance than did girls.

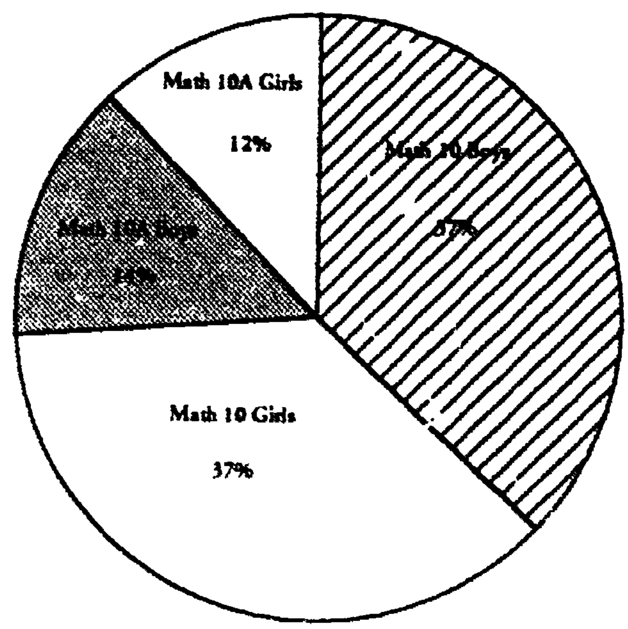
Difficulty ratings of boys and girls were similar on five topics. Boys, however, rated the following topics as considerably easier than did girls: area, perimeter, and volume; problem solving; and geometry. Girls, on the other hand, rated equations and expressions as considerably easier, corresponding to their achievement results in which they outperformed boys on this topic.

Girls enjoyed working with fractions, decimals, and percent; equations and expressions; and exponents more than boys. The only topic on which boys expressed an enjoyment level at least five percentage points higher than girls was on geometry.

(iii) Course Enrolments

Further analysis of enrolments in Math 10 and Math 10A provided information on the the percent of boys and girls in each course. Results are shown in Figure 6-6.

Figure 6-6. Enrolment by gender.



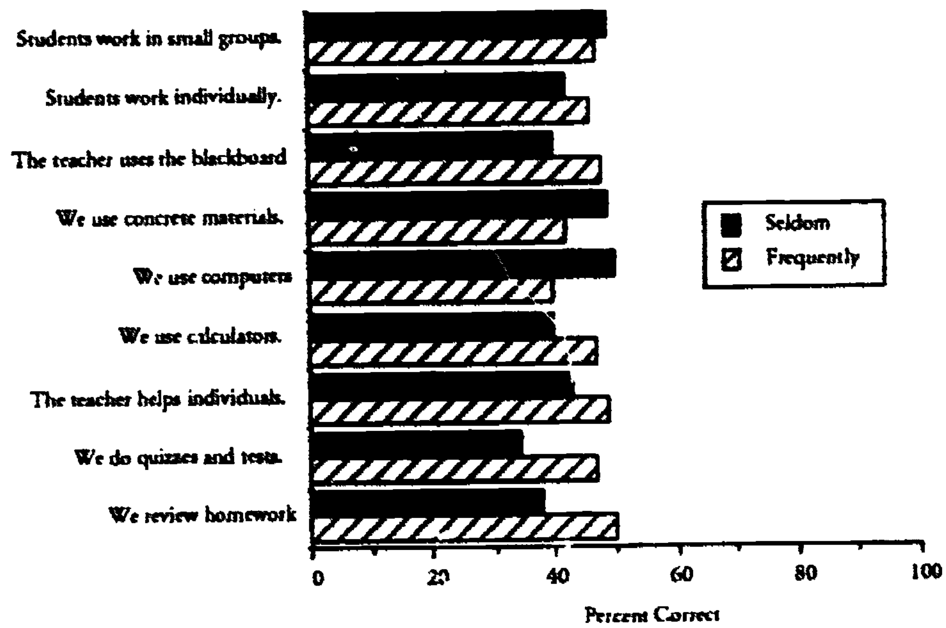
Identical proportions of boys and girls were enrolled in Math 10. Although a slightly higher proportion of boys were enrolled in Math 10A, little difference was found between genders.

Classroom Practices

A further review of information on the frequency of classroom activities involved an examination of achievement results associated with responses to these questions. The proportion of the students who chose each of the "frequently" and "seldom" categories for each activity was shown earlier in Table 6-3. A summary of the further analysis, showing the overall mean achievement score for students who selected each of two response categories, is shown in Figure 6-7.

These results show positive relationships between test scores and frequent use of the following activities: tests and quizzes, use of calculators, and time spent on homework review. This finding may suggest that to improve student achievement, teachers spend time assigning and reviewing homework, administer quizzes and tests frequently, and continue to permit and encourage the use of calculators in all aspects of the teaching and learning of mathematics.

Figure 6-7.
Class practices and achievement.



Summary

Information on students' backgrounds, attitudes, and perceptions was collected for all students who were either enrolled in Grade 10 or else in a Grade 10 level mathematics course. Achievement results, on the other hand were examined for three distinct groups: all students, Math 10 students, and Math 10A students. Four different booklets, administered randomly within classrooms, were used to collect this information. Each booklet included a number of questions related to background and perceptions, as well as 60 achievement items. Twenty of the items were common, 20 were specific to Math 10, and 20 related to Math 10A.

Background Information

A total of 31 500 booklets were completed, 50.5 percent by males and 49.5 percent by females. The vast majority, 89 percent, of students were either 15 or 16 years of age at the time of administration. Seventy-five percent were enrolled in a 10-month program and 23 percent in a semestered one. Of these, slightly more than 25 percent were enrolled in Math 10A. The proportions of students enrolled in the regular English and French immersion programs were as follows: regular program in English, 96 percent; French immersion, three percent; and *Programme-cadre de français*, one percent.

Results showed that a significant number of students planned to continue the study of mathematics into their Grade 12 year. For example, 45 percent reported plans to take either Math 12 or Survey Math 12, and 11 percent planned to enroll in an enriched mathematics course at that level. Forty-five percent planned to enter either a university or else enroll in a university transfer program at a college after graduation. Only four percent had plans to look for a full-time job immediately after completion of secondary school.

Attitudes and Perceptions

Most students agreed there was need for mathematics to get a good job, 75 percent, and that it is used in most jobs, 72 percent. However, only 30 percent reported they would like a job after leaving school, where they have to use mathematics.

Students perceived the most important topic to be fractions, decimals, and percent; whereas trigonometry was rated as the least important. The easiest topics were the following: area, perimeter, and volume; working with exponents; estimating answers; and fractions, decimals, and percent. Trigonometry, data analysis, and problem solving, on the other hand, were rated as the most difficult topics. Ratings for enjoyment were lower than those for importance and easiness. Fractions, decimals, and percent was rated the most enjoyable topic, whereas data analysis and trigonometry were rated the least.

Classroom Practices

Classroom practices related to direct instruction were reported as occurring most frequently. These activities included the following: review of homework, use of quizzes and tests, and individual seatwork. The activities which occurred least frequently were the uses of computers and concrete materials.

Achievement Results

Two hundred and forty achievement items were distributed evenly among the four booklets. The items measured learning outcomes from the following strands: number and operation, data analysis, geometry, measurement, and algebra. A summary of results for each strand follows.

Number and Operation. Students did well on items which involved straight-forward consumer applications, order of operations, and simplification of numerical expressions with positive integer exponents. They experienced difficulty, however, on items with negative values or coefficients, and on those which required the extension of numerical patterns. In particular, Math 10A students did poorly on items involving mixed numbers and scientific notation. Math 10 students had similar difficulty with items containing numbers under the radical sign.

Data Analysis. Items involving the reading of graphs or frequency distributions were done well. However, those which measured the probability of an event occurring were poorly done. Findings from this strand indicate that, in many classrooms, the topic of probability was not taught. The poor level of student achievement and low opportunity to learn ratings for many items in this strand suggest a need for the following: further clarification of the curriculum, provision of more teacher inservice, and the development of additional resources.

Geometry. Students did relatively well on items which involved direct relationships between angles formed by transversals and parallel lines. However, they experienced difficulty with the application of geometric concepts and with

spatial relationships. The topic of proof, however, was done well by Math 10 students.

Measurement. Given the formula, most students were able to correctly answer items involving perimeter and surface area.

However, items which involved applications of area and volume, and the properties of complex figures were not done well. Greater emphasis needs to be given to topics in this strand.

Algebra. Most students were able to simplify algebraic expressions and to evaluate expressions, provided there were no parentheses and negative coefficients. Items which included these characteristics, however, were poorly done. It is recommended that teachers review the items contained in this strand to gain direction for course planning and for the development of resource materials.

Change in Achievement

A total of 21 items from the 1985 assessment were repeated in 1990 in order to examine change in achievement. The items were divided into the following reporting categories: whole numbers, rational numbers, data analysis, and measurement.

Improvement was shown in all of the reporting categories, with mean differences ranging from a low of five percentage points for data analysis to highs of nine percentage points on whole numbers and rational numbers. The two factors which likely had the greatest effect on these results were the revised mathematics curriculum, in which data analysis and applications have greater emphasis, and the use of calculators, allowed for the first time on the 1990 assessment.

Reporting Categories

Further analysis of the data examined achievement results based on school organization, gender, and classroom practices. Results by gender were also examined for attitudes and perceptions, and course enrolment. A brief review of findings follows.

School Organization. Results of students enrolled in full-year programs were slightly higher than those in a semestered school organization. The differences, however, were not great. It is likely that results for students enrolled in a Semester 1 course were affected because some of the content was forgotten. Results for students in a Semester 2 course, on the other hand, were likely affected since some of the mathematics may not have been taught at the time the assessment was administered.

Gender Differences. Boys outperformed girls on all of the strands, except algebra. Differences were not great, however, ranging from two to five percentage points across strands. The mean score for boys was also higher, five per-

centage points, on items measuring achievement for problem solving. A higher percent of boys indicated they would like a job in which mathematics is used after completion of school. Topics which are more abstract and less familiar received higher ratings of impor-ance and easiness from boys. Girls, on the other hand, rated the enjoyment of most topics higher than did boys. These differences may be partly affected by students' and teacher's attitudes, as well as applications in textbooks, which may favor the interests of boys more than girls.

Classroom Practices. Findings showed that students who reported frequent occurrence of the following activities in their classrooms scored higher than those who did not: use of quizzes and tests, use of calculators, and time spent on homework review and individual seatwork. On the other hand, students who reported infrequent occurrence of the following activities scored higher, on average, than those who reported frequent occurrence: use of computers, use of concrete materials, and small group instruction. These results suggest that students enrolled in classes in which activities associated with direct instruction occur frequently score higher than those who are not.

References

Kifer & Robitaille, (1989). Attitudes, preferences, and opinions. In D. F. Robitaille and R. A. Garden (Eds.) *The IEA Study of Mathematics II: Contexts and Outcomes of School Mathematics.* Oxford: Pergamon Press.

Ministry of Education, (1988). *Mathematics Grade 7-12.* Victoria: Program Development Division.

Robitaille, D.F. (1981). (Ed.). *The 1981 B.C. Mathematics Assessment: General Report.* Victoria: Ministry of Education.

Robitaille, D.F. & O'Shea, T.J. (1985). (Eds.) *British Columbia Mathematics Assessment 1985. General Report.* Victoria: Assessment, Examination, and Reporting Branch.

Robitaille, D.F. & Sherrill J.M. (1977). *The B.C. Mathematics Assessment: Summary Report.* Victoria: Queen's Printer.

Chapter 7

Performance on Open-ended Problems

Walter Szetela

Since 1987 when the revised mathematics curriculum was introduced in British Columbia, problem solving has been a major strand in elementary school mathematics. Strategies are a major focus of the problem-solving strand from Grade 1 through Grade 7. Although problem solving is not a distinct strand in the secondary school grades, it is specified in the Curriculum Guide (1987) that the strategies introduced in the elementary grades should be practiced and reinforced throughout the teaching of secondary school mathematics. The importance of problem solving and its emphasis in the new British Columbia mathematics curriculum make it highly desirable that, along with the 1990 assessment of mathematics knowledge, skills, and concepts in British Columbia, a major assessment of problem solving should also be undertaken. The previous mathematics assessment in British Columbia (Robitaille & O'Shea, 1985) did include a special and separate set of open-ended problems; however, the present assessment is much greater in scope and especially relevant in view of the revised mathematics curriculum.

Goals of the Open-ended Problems Assessment

In addition to the general goals and major questions listed in Chapter 1 for the Provincial Learning Assessment Program, there were more particular goals and objectives for the assessment of mathematical problem solving. The principal objective for assessment of students' ability to solve open-ended problems is to provide information about the strengths and weaknesses in the problem-solving strand of the British Columbia mathematics curriculum which can be used to improve instruction and learning in problem solving. Answers to questions related to students' knowledge and utilization of specific problem-solving strategies in Grades 4, 7, and 10 are needed in order to determine the effectiveness of instruction in problem solving and to guide planning for better instruction where it is needed. For example, the guess-and-test strategy has been a requirement of the mathematics curriculum for only a few years, and little is known about how well students use this strategy at various grade levels. In addition to knowledge about particular strategies it is desirable to determine to what degree students are learning how to assimilate problem facts, make connections among those facts, make decisions about appropriate strategies, and carry out sound procedures while utilizing such strategies as they attempt to reach the problem goals. In particular a number of questions for which some answers would be helpful are the following:

- What problem-solving strategies are utilized by students at the three grade levels being assessed?
- How well are these strategies implemented in the course of solving problems at each grade level?
- Do students fare better with translation problems (traditional word problems requiring mainly calculation) than with process problems which require lists, pattern recognition, guessing and testing, etc.?
- To what extent are experience and maturity significant with respect to utilizing certain strategies and solving problems in general?

- How well are students able to solve problems containing a large number of facts and conditions?
- How well are students able to evaluate a problem solution?

In addition to these achievement questions, it is important to know how students feel about problem solving because such feelings influence motivation which is essential to success in solving problems. The following affective questions were addressed in the assessment:

- At each grade level, what is the state of students' attitudes toward problem solving?
- After attempting to solve problems, how do students feel about the problems?

A great deal of research has focused on differences between males and females in mathematics. Differences in higher-order thinking skills such as problem solving are especially important. Questions about the extent of these differences need to be answered to provide direction for improving performance of males or females where such differences occur. The following questions are important:

- Do males and females achieve different performance levels in problem solving?
- Do males and females have different attitudes toward problem solving?

Construction and Development of Items

The problem-solving strand of the new mathematics curriculum includes a variety of strategies for solving problems: e.g. guessing and testing, looking for a pattern, making a systematic list. Along with these strategies, at each of Grades 1 to 7, the Mathematics Curriculum Guide (Ministry of Education, 1987) specifies Intended Learning Outcomes (ILO's) for problem solving including the phases of problem solving: understanding, solving, and consolidating and extending. Although problem solving is not a distinct strand in the Grade 10 Mathematics Curriculum, teachers are expected to integrate problem solving into all mathematics topics including practice with the strategies introduced in the earlier grade levels.

These curricular requirements and recommendations served to guide the construction of the open-ended problems so that each set of problems would include traditional complex translation problems and several problems which would require the use of other strategies in addition to selection of appropriate numerical operations. A plan for development and construction of the assessment items was presented to members of the Contract Team which gave approval to the plan. Following construction of a draft of open-ended items at each grade level, members of the Contract Team examined the items and made suggestions for minor revisions. In the spring of 1989 a revised form of the open-ended items was piloted in three Grade 4 and three Grade 7 classes. The items were found to be generally suitable but additional revisions were made and again reviewed by members of the Contract Team. In January 1990 another version of the assess-

ment items was piloted in three Grade 4 classes, three Grade 7 classes, and four Grade 10 classes including two Grade 10A classes. Again responses from the pilot classes suggested changes and refinements which were used to construct the final versions of the forms for the assessment of open-ended problems.

The mathematical concepts and skills required to solve all of the problems were within the scope of the mathematics curriculum at each grade level. Although the curriculum for Mathematics 10A encompasses lower levels of mathematics content than that of Mathematics 10, no Grade 10 problem required more mathematical content than is supposed to be taught in Mathematics 10A. Although the curriculum guide for secondary mathematics does not have a specific strand for problem solving, the same range of strategies for solving problems in elementary grades was included in the Grade 10 problems.

Format and Content of the Open-ended Problem Booklets

At each of the three grade levels two booklets consisting of open-ended problems, Forms Q1 and Q2, were administered. Each booklet contained 6 problems to be solved, and one solved problem containing errors in which the student was asked to judge the quality of the solution. The Q1 forms also contained two questions asking the students what they did before and after solving a problem. The Q2 forms contained an 8-item scale of attitude toward problem solving. Following each problem was a sequence of four words. Students were asked to select the one that described their feelings about each problem or to choose their own word. All of the Q-forms were translated into French for those students who were learning mathematics in French.

Six of the twelve problems on the two Q-forms in Grade 7 were identical to problems on the Grade 10 Q-forms. One problem was identical for all three grade levels.

Participation Rates

While the multiple-choice items were completed by virtually all students in Grades 4, 7, and 10, it was not feasible to administer the open-ended items to all students in those grade levels. The solution of each open-ended problem requires careful examination and the time needed to evaluate more than 100 000 Q-forms would be excessive. An eight percent sample of Grade 4, 7, and 10 classes was randomly selected to write the Q-forms, including classes taught mathematics in French. In each class half the students completed Form Q1 and the other half completed Form Q2. The Q-forms were completed by about 3250 Grade 4 students, 3700 Grade 7 students, and 3100 Grade 10 students.

The Q-forms were administered in May, within a few days of the universal administration of the main body of multiple-choice learning assessment items.

Scoring Procedures

The evaluation of open-ended problems is complex and time consuming. Scales for evaluating problem solving, no matter how well constructed, suffer

from inconsistencies because even carefully prepared guidelines cannot completely eliminate the subjectivity of the evaluator. A well-known evaluation scale for problem solving that measures three phases of problem solving – understanding, solving, and answering – was constructed by Charles and Lester (Charles, Lester, & O'Daffer, 1987). One of the limitations of this scale is that measurement of the first two phases, understanding and solving, are not independent. In order to provide a measure for understanding, one must survey the process of solution. As a result, scores assigned for Phases 1 and 2 are very often the same (Szetela, 1987). A second type of scale for evaluating problem solutions surveys the entire solution process. A score is assigned proportional to the degree of progress in attempting to reach a complete solution. Such scales are quite natural to use and one constructed by a Polish researcher (Rabijewska, 1981) is very similar to one constructed independently by Rick Woods, a teacher in the Richmond School District (Woods, 1982).

In view of the work involved in evaluating about 10 000 sets of solutions to problems, it was imperative that the evaluation scheme chosen be relatively simple as well as reasonably consistent. Initially, it was planned to use the Woods scale shown in the left half of Figure 7-1 because it appeared to satisfy these requirements.

Following considerable discussion it was decided to construct a new scale which would focus on strategy implementation instead of numerical grading as in the Woods scale. That coding scheme, called the Student Response Characteristic Coding Scheme (SRCCS), was based on the Woods scale, but included nine categories of strategy implementation. The close relationship between the Woods numerical grading scale and the SRCCS is shown in Figure 7-1.

Figure 7-1. Woods evaluation scale and strategy implementation scale.

Woods Evaluation Scale		SRCCS Coding Scheme	
Score	Solution Stage	Categ	Strategy Implementation
0	No work shown	1	No work shown
2	Pertinent facts shown with no procedure	2	Identifies data only
		3	Problem misinterpreted
4	Pertinent facts shown with inappropriate procedure	4	Strategy not clear
		5	Strategy initiated but incomplete or poorly implemented
6	Appropriate plan introduced; some progress but wrong turn taken or failure to complete a good plan	6	Conditions overlooked or possibilities not exhausted
		7	Multiple secondary errors
8	Clear and appropriate plan developed but error in calculation or transcription or answer incomplete	8	A single secondary error
		9	Appropriate and complete
10	Correct and complete answer		

In addition to a scale for strategy implementation the SRCCS also included categories for the answer to the problem, for the statement of the answer, and for the identification of the principal strategy used in each solution as shown in Figure 7-2.

Figure 7-2. Answer and statement codes and problem-solving strategies.

Answer	Statement	Strategy Used	
1. Correct	1. Complete	Number sentence	Draw diagram
2. Incorrect	2. None required	Select numerical operations and calculate	Search for a pattern
3. Undetermined	3. No units	Use algebra	Logical reasoning
4. Blank	4. No context	Non-systematic list	Simpler case
	5. No statement	Systematic list (make a table, graph or list)	Work backwards
		Guess and check	Undetermined

Following training sessions for six teacher leaders, 80 teachers met for a period of five days for training in the use of the SRCCS and for evaluation of the approximately 10 000 sets of problems. The SRCCS proved to be efficient in e.aluating the Q-forms and consistent as well. Consistency of the categorizations was verified by second evaluations of samples of the Q-forms following the initial evaluations.

Scoring of Problem 7

On each of the Q-forms, a distinctly different type of challenge followed attempts to solve the first six problems. Problem 7 was presented as an already solved problem, but it contained a significant error. Students were asked to evaluate the solution of Problem 7 by answering two questions about the solution. The problem was designed to provide information about students' ability to evaluate a solution rather than find solutions as in problems 1 to 6. In view of time limitations it was decided to evaluate only a sample of the Q-forms for assessment of this item. About 1000 responses to Problem 7 were evaluated in all, or about 160 responses from each of the six Q-forms.

On each Q-form, Problem 7 included two questions designed to give students an opportunity to analyze the solution and discover a significant error in the solution. A set of response categories to those questions was presented to a panel of 80 teachers who then proceeded to evaluate the responses. Judgment of the student responses as indicative of ability to examine a solution critically was determined mainly on the basis of whether or not the student could identify the major error in the problem.

Results of Open-ended Problems Assessment

Results of the assessment of problem solving are presented mainly with respect to quality of strategy implementation as shown in Table 7-1. The nine levels of strategy implementation in the SRCCS form a hierarchical sequence ranging from no work shown (Category 1) to complete and correct solution

Table 7-1.
Mean percentages of students in each strategy implementation category. (Twelve problems in each category.)

Strategy Implementation Category		Grade 4	Grade 7	Grade 10
1	No work shown	21	24	20
2	Identifies data only	0	1	1
3	Problem misinterpreted	22	20	12
4	Strategy not clear	3	8	7
5	Strategy initiated but incomplete or poorly implemented	7	10	15
6	Conditions overlooked or possibilities not exhausted	11	9	10
7	Multiple secondary errors	0	0	1
8	Single secondary error	4	2	3
9	Appropriate and complete	31	24	32

(Category 9). Category 6, conditions overlooked or possibilities not exhausted, can be considered to be the minimum level for satisfactory achievement on any given problem. This category typically describes a solution which shows significant understanding of a problem and significant progress toward solution, although the solution may fall short of completion. Problem solving is a complex process, and complete and correct solutions cannot be expected with the same frequency as in computational exercises or other routine mathematical tasks. The difficulty level of a given problem depends on many factors including prior experience, context, familiarity with general strategies, and maturity. Not surprisingly, there was a wide range of levels of strategy implementation on the six problems of each of the six Q-forms.

The unexpectedly high mean percentages of students who showed no work in their attempts to solve problems indicate that many students often find solving problems a task too formidable to attempt. However, there was a wide range of difficulty levels of the problems. Figure 7-3 shows an example of a problem at each grade level which students found less difficult than others.

Figure 7-3.
Examples of less difficult problems at each grade level and percents of students showing no work and reaching implementation level 6 or higher.

	No work	Level 6 - 9
Grade 4 Problem		
Small candies cost 2 cents each and large candies cost 5 cents each. Susan bought 3 candies. How many different amounts could Susan have spent?	13	54
Grade 7 Problem		
A music club raised $125 to buy tickets for a concert. Tickets cost $9 each. After buying tickets for every club member, $17 was left. How many members are in the music club?	11	63
Grade 10 Problem		
A plane took off with a full load of 116 000 L of jet fuel. The plane used 9000 L of fuel per hour. It flew at an average speed of 800 km/h. When the plane landed it had 44 000 L of jet fuel left. How long was the flight?	11	71

Other problems were more challenging as indicated by examples shown in Figure 7-4. The high percentages of problems with no work shown reflects not only the difficulty of the problem but also inexperience in solving such problems, unwillingness to attempt such problems, and inadequate awareness of problem-solving strategies.

Figure 7-4. Examples of more difficult problems at each grade level and percents of students showing no work and reaching implementation level 6 or higher.

	No work	Level 6 - 9
Grade 4 Problem		
Petra read a book with 160 pages in 4 days. Each day after the first, she read 10 pages more than the day before. How many pages did she read on the fourth day?	34	17
Grade 7 Problem		
A hockey team scored 70 goals in 24 games. In 10 of the games the team scored 2 goals in each game. In the other games they scored either 3 goals or 4 goals. The team won only when they scored 4 goals. How many games did the team win?	32	15
Grade 10 Problem		
We can write any whole number using the digits 0 to 9. 59 has a 2 digits: 5 and 9. 708 has 3 digits: 7, 0, and 8. 4633 has 4 digits: 4, 6, and 3 used twice. In numbering the pages of a book, 777 digits were used. How many pages are in the book?	43	10

Cross-Grade Results

The effects of maturity and experience on success in solving problems were investigated by including the same problem given at all three grade levels and by having several identical problems in Grades 7 and 10. Figure 7-5 shows a problem which was administered at all three grade levels and the percentages of categories of strategy implementation.

Figure 7-5. Strategy implementation problem for Grades 4, 7, and 10: mean percent correct.

We want to number the pages of a book with 222 pages. How many times will a 7 be printed?

	Grade Level		
Strategy Implementation Category(ies)	*4*	*7*	*10*
No work or only facts written	30	16	2
Problem misinterpreted or strategy not clear	42	26	17
Strategy initiated but incomplete or poorly implemented	3	9	5
Conditions overlooked or possibilities not exhausted	22	31	39
Secondary errors only or appropriate and complete	5	18	18

Not surprisingly, Grade 4 students were less able to comprehend the problem situation than students in Grades 7 and 10. About 72 percent of Grade

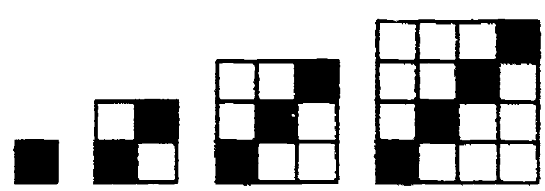
4 students did little or no work, misinterpreted the problem situation, or were unclear in their strategy implementation. This compared with about 40 percent of the students in Grades 7 and 10 in the weakest strategy implementation categories. About 27 percent of Grade 4 students made significant progress, including the 5 percent who solved the problem completely or made secondary errors only. About 49 percent of Grade 7 students made significant progress, including 18 percent who were completely correct or made secondary errors only.

Grade 10 students did not fare much better on this item than Grade 7 students. About 57 percent of Grade 10 students made significant progress, including 18 percent who were completely correct or made secondary errors only. The large proportion of students in the category of conditions overlooked or possibilities not exhausted is not unexpected in a problem of this type. The most common oversight was the extra 7s in the 70s decades. The low success at all grade levels indicates that more instruction and practice are needed to promote success with the strategies of making a systematic list and identifying number patterns.

In contrast to the "How many 7s problem," the problem and results displayed in Figure 7-6 illustrate a considerably higher degree of success at the Grade 10 level than at the Grade 7 level.

Figure 7-6. Strategy implementation results for a Grade 7 and 10 problem.

Problem Look at the pattern of black and white square tiles.
How many black tiles should be in the TENTH figure?



Black tiles cost $5 and white tiles cost $1.
How much will a square floor with 20 tiles on each side cost?

Strategy Implementation Category(ies)	*Grade Level* 7	*Grade Level* 10
No work or only facts written	33	18
Problem misinterpreted or strategy not clear	41	29
Strategy initiated but incomplete or poorly implemented	11	18
Conditions overlooked or possibilities not exhausted	4	0
Secondary errors only or appropriate and complete	13	35

Only about one eighth of Grade 7 students had a correct or nearly correct solution, compared to about one third of Grade 10 students. This large difference contrasts with the approximate equality of correct and nearly correct solutions for the two grade levels on the "7s" problem. Grade 7 students may have

been more prone to misinterpret the problem because of difficulties with the syntax. The phrase "20 tiles on each side" was often misinterpreted as 20 tiles on the boundary sides only of the square floor. This interpretation is reasonable, especially if students ignore the pattern of tiles illustrated in the first question which was sometimes considered to be distinct and not related to the main goal of the problem. Such reasonable misinterpretations illustrate the general difficulty of making problem statements so clear that only a single interpretation is reasonable.

The following problem illustrates that problems involving percent are much more difficult for students in Grade 7 than those in Grade 10.

> Mike, Larry, and Les earned money mowing lawns.
> One week Mike worked for 20 h, Larry worked for 12 h, and Les worked for 18 h.
>
> a) What percent of the total number of hours did Mike work?
>
> b) During that week the boys were paid a total of $225. How much of the money should Mike receive?

About 26 percent of Grade 7 students obtained the correct answer to part (a) compared to about 64 percent of Grade 10 students. About 19 percent of Grade 7 students obtained the correct answer to part (b) compared to about 55 percent of Grade 10 students.

The results for all seven problems common to both Grades 7 and 10 are summarized in Table 7-2.

Table 7-2. Results on identical problems for Grades 7 and 10: percent complete solutions.

Problem Context	Best Strategy	Grade 7	Grade 10
Lawns (part a)	Select operations	26	64
Lawns (part b)	Select operations	19	55
Music tapes	Systematic list	40	56
How many 7's	Systematic list	9	8
Free tickets	Systematic list	0	0
Hockey	Guess and test	14	20
Tiles	Pattern	12	32

One problem was extremely difficult, and less than one percent of students in either of Grades 7 or 10 were able to obtain the correct answer. The problem involved many lists. The 7s problem was the next most difficult problem. On the remaining five problems, Grade 10 students had a clear superiority over Grade 7 students, as would be expected.

Problem-Solving Results by Gender

A considerable body of literature indicates that there are gender differences in mathematics learning. In a report of the National Assessment of Educational Progress for Grades 3, 7, and 11 in the United States (Dossey, Mullis, Lindquist & Chambers, 1988) it is stated that:

> Females tend to outperform males on tasks where there is an obvious procedural rule to follow, while the reverse seems to be true when the strategy for solving the problem is less apparent. At all three grade levels, the NAEP results show a consistent advantage for females in the area of knowledge and skills compared to a consistent advantage for males in the area of higher-level applications. (pp. 56-57)

Differences are largest in the secondary grades but are declining (Friedman, 1989). Reasons for these differences have often been attributed to differences in exposure to mathematics. In senior grades males have traditionally enrolled in mathematics courses in larger numbers than females (Fennema and Sherman, 1977).

Table 7-3 shows the mean percent correct on the six problems from each Q-form at each grade level. Results are consistent with other studies on gender differences in mathematics and especially higher-level thinking. Differences between males and females in obtaining correct answers on the assessment problems are small in Grade 4 and Grade 7. In Grade 10 males have a three to six point margin over females.

Table 7-3. Means of percentages of correct answers for males and females.

Grade	Form	Boys	Girls	Difference (Girls - Boys)
4	Q-1	44	43	-1
4	Q-2	31	33	2
7	Q-1	28	28	0
7	Q-2	33	32	-1
10	Q-1	53	47	-6
10	Q-2	33	30	-3

On most problems differences between males and females were not large. Out of 36 problems there was a difference of five percent or more on only seven problems. The largest difference was a Grade 10 problem involving concepts of rate and average. Inexplicably, 51 percent of males had a complete and correct solution for this problem compared with only 33 percent of females.

> Mr. Moon drove for 4 h at 80 km/h.
> He drove 1 more hour in heavy traffic at 40 km/h.
>
> What was his average speed for the trip?

The large difference between males and females on this one problem is a

puzzling anomaly. The sample size is large enough to render unlikely the conclusion that the result is merely a statistical aberration. The problem appears to be brief and clearly stated. In Grade 10, do males have a better understanding of the concept of average rate than females? Are males more likely to notice the importance of considering the periods of time when averaging two different rates? Do males have more experience with rate situations?

Attitudes Toward Problem Solving

The research literature on affective differences in mathematics suggests that attitudes toward mathematics are somewhat positive in the primary grades but gradually decline in the middle grades and become even less positive in the upper grades. The literature also suggests that females are more anxious about mathematics and feel less confident about their ability to do mathematics. To obtain data that would shed light on attitudes toward problem solving among students in British Columbia, an 8-item scale of attitude toward problem solving was constructed. This scale, shown in Figure 7-7, is a short, modified version of other scales of attitudes toward problem solving: e. g. (Whitaker, 1976). The scale was completed by students on Form Q-2 immediately preceding their attempts to solve the problems.

Figure 7-7. Scale of attitude toward problem solving.

BEFORE YOU START THE PROBLEMS, LOOK AT THE STATEMENTS BELOW. CIRCLE THE ANSWERS THAT TELL BEST HOW YOU FEEL ABOUT MATH PROBLEMS.

1. I enjoy solving math problems.
   Strongly agree   Agree   Undecided   Disagree   Strongly disagree
2. When my teacher gives us math problems to solve, I get uncomfortable.
   Strongly agree   Agree   Undecided   Disagree   Strongly disagree
3. Once I start a math problem I don't give up until I solve it.
   Strongly agree   Agree   Undecided   Disagree   Strongly disagree
4. I would rather solve only easy problems.
   Strongly agree   Agree   Undecided   Disagree   Strongly disagree
5. Problems that make you think are more fun than easy problems.
   Strongly agree   Agree   Undecided   Disagree   Strongly disagree
6. If I had the choice, I would rather solve math problems than do arithmetic drills or exercises.
   Strongly agree   Agree   Undecided   Disagree   Strongly disagree
7. Math would be more interesting if we had more problems.
   Strongly agree   Agree   Undecided   Disagree   Strongly disagree
8. I think I'm good at solving problems.
   Strongly agree   Agree   Undecided   Disagree   Strongly disagree

This scale was completed by 823 males and 717 females in Grade 4, by 883 males and 908 females in Grade 7, and by 761 males and 752 females in Grade 10. The wording of all items except Items 2 and 4 was "positively phrased." In the analysis of the data the numerical results on items 2 and 4 have

been adjusted to be consistent with the positively phrased items. Item responses were scored from 1 (strongly agree) to 5 (strongly disagree).

Results from the Attitudes toward Problem-Solving Scale

Students' responses to the attitude scale are summarized in Table 7-4 which is shown below. Lower scores indicate more positive attitudes.

Table 7-4. Male-female item means for attitudes toward problem solving.

Item	Grade 4		Grade 7		Grade 10	
	Male	Female	Male	Female	Male	Female
Enjoy solving	2.51	2.40	2.89	2.99	3.18	3.20
Uncomfortable	2.48	2.46	2.47	2.53	2.59	2.71
Don't give up	2.16	2.13	2.65	2.73	2.97	3.02
Prefer easy	2.80	2.79	3.02	3.08	3.12	3.26
Thinking fun	2.46	2.48	2.67	2.75	2.82	2.92
Problems-drill	2.76	2.76	2.78	3.12*	2.80	3.08*
More problems	3.10	3.09	3.32	3.48*	3.44	3.58*
Good at solving	2.39	2.58*	2.63	2.92*	2.80	3.22*
Mean	2.58	2.59	2.81	2.95	2.97	3.13

* Differences significant at 0.01 level.

Table 7-4 shows that responses on most items between males and females are similar especially in Grade 4. All seven significant differences indicate less positive attitudes for females. It is also apparent that there is a general steady deterioration of attitude toward problem solving from Grade 4 to Grade 10. This deterioration is more apparent when the results are tabulated in terms of the percentages of students who gave positive responses (strongly agree or agree) as shown in Table 7-5.

Table 7-5. Male-female item percents for positive attitudes toward problem solving.

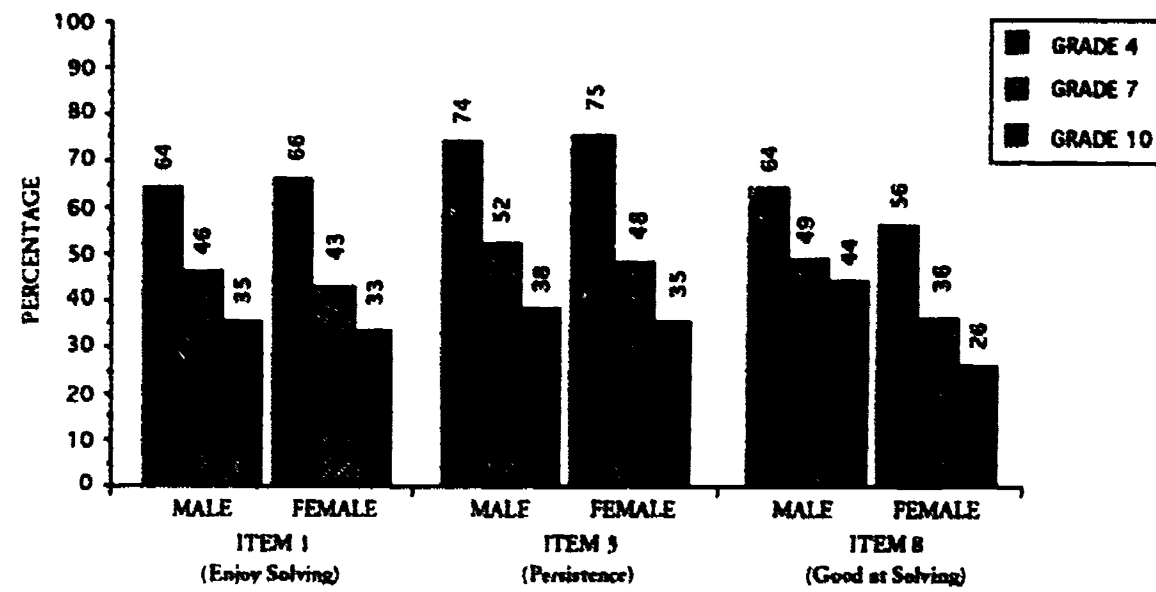
Item	Grade 4		Grade 7		Grade 10	
	Male	Female	Male	Female	Male	Female
Enjoy solving	64	66	46	43	35	33
Uncomfortable	60	63	61	59	57	52
Don't give up	74	75	52	48	38	35
Prefer easy	54	54	45	40	43	35
Thinking fun	61	61	53	49	47	40
Problems-drill	50	50	46	39	43	35
More problems	38	37	27	19	18	11
Good at solving	64	56	49	36	44	26
Mean	56	55	47	42	36	33

* Results adjusted for negatively phrased items.

As Item 1 indicates, about two-thirds of students in Grade 4 report enjoyment of problem solving, but in Grade 10 only about one-third of students do so. Item 3 also reveals a sharp decline with about half as many students in Grade 10 reporting persistence in solving problems compared to students in Grade 4.

Item 7 shows that more than a third of students in Grade 4 would prefer to have more math problems, but in Grade 10 the percentages are much lower with only about 11 percent of females preferring to have more problems. Sharp drops in confidence in solving problems are indicated from the results on Item 8, especially for females with 56 percent agreeing that they are good in solving problems in Grade 4 but only 26 percent in Grade 10. Percentages of positive attitude responses for males and females for Items 1, 3, and 8 are shown in Figure 7-8 in bar graphs.

Figure 7-8. Percentages of males and females indicating positive attitude responses for selected items.



Problem-Solving Performance in Classes Taught in English and French

The numbers of students taught mathematics in French are considerably smaller than those taught in English. The numbers of students and percent of French pupils in the sample are shown in Table 7-6.

Table 7-6. Number of students in sample of classes taught in English and in French.

Grade	English	French	Percent French
4	2954	294	9
7	3346	379	10
10	3009	131	4

The mean percentages of complete and correct solutions on the overall clusters of 12 problems for Grade levels 4, 7, and 10 for classes taught in English and in French are shown in Table 7-7. Because of the small sizes of the samples of French-taught mathematics classes in the assessment, the results are presented here with little comment.

Table 7-7. Mean percentages of complete and correct solutions in classes taught in French and in English.

	Percent Complete and Correct Solutions		
Grade	English	French	Difference (English–French)
4	31	27	4
7	23	32	-9
10	32	41	-9

The percentages of complete and correct solutions for Grade 4 shown in Table 7-7 indicate that students in the sample of mathematics classes taught in English had a higher percentage of complete and correct solutions than those taught in French. However, at both Grades 7 and 10, students who were enrolled in mathematics classes taught in French had a higher percentage of complete and correct solutions than those taught in English.

Assessment of Critical Analysis in Problem Solving

Solving problems requires awareness of the problem situation, decision making, and continuous regulation of the strategy implementation. These metacognitive actions and the ability to analyze stages in the solution process are difficult to assess unless the solver has clearly explained the entire solution process. Often students solve problems and obtain answers with very little work shown. In such cases the teacher must guess the extent of the student's awareness and infer which decisions were made, with little conception of any monitoring in which the student was engaged. One way to assess critical analysis and metacognitive actions in problem solving is to present an already solved problem where the task is to evaluate the solution rather than solve a problem. By asking suitable questions with respect to the given solution, one can obtain a reasonable conception of the extent of metacognition practiced by the student. Although the given problem is already solved (correctly or not), the student must acquire a suitable representation of the problem situation, be able to monitor the solution procedure, and decide on the appropriateness of the procedure and reasonableness of the answer. Figure 7-9 shows a solved problem containing a significant error given to Grade 7 students (Problem 7, Form Q-1) along with questions which cannot be answered well without critical analysis or metacognitive engagement in the given solution.

Figure 7-9. Solution for critical analysis (Grade 7, Form Q-1).

Problem A bowl contains 10 apples and oranges.
Apples cost 5 cents each and oranges cost 10 cents each.
All together the fruit is worth 70 cents.
We want to find how many apples are in the bowl.
Beth tried to solve the problem this way.

apples	oranges						
				5	10		
5	10			5	10		
5	10			10	10		
5	10	50			10	60	
5	10	25			10	10	
5	10	75	too high		10	70	just right
25	50				60		

There are 2 apples in the fruit bowl.

1. Is Beth's way of solving the problem a good one?
   Tell why you think it is or is not a good way.

2. Did Beth get the right answer?
   Explain why she did or did not.

For each of the two Q-forms at Grades 4, 7, and 10, a sample of about 150 to 175 responses to Problem 7 was examined by a team of teachers who had also participated in the evaluation of the first six problem solutions. A total of 985 Problem 7 responses was evaluated. The responses were used to determine three levels of critical analysis :

Level 1: Responses are simplistic. There is no indication of ability to evaluate a solved problem in a critical manner.

Level 2: Responses indicate a reasonable attempt to comprehend and critique the solution, although with limited success. At least one major error was overlooked.

Level 3: Responses indicate a careful examination of the solution, including identification of the significant error.

Results for Problem 7

Table 7-8 shows the percentages of students classified as being at each of the three levels of critical analysis in problem solving.

Table 7-8.
Percent distribution of levels of critical analysis in problem solving.

	Grade 4	Grade 7	Grade 10
Number of students	314	339	332
% at Level 1	66	56	76
% at Level 2	25	9	7
% at Level 3	10	36	18

The results show that, based on the criteria describing three levels of critical analysis, most students in Grades 4, 7, and 10 were at the lowest level in critical examination of a solution to a problem. These results must be treated with caution for several reasons. They are based upon responses to a single problem. The problem and the solution shown may not have attracted sufficient student interest and study to elicit thoughtful responses to the questions. Students have little or no experience in critically analyzing problem solutions. The criteria for the three levels of critical analysis are arbitrary and imperfect. The comparative results themselves cast doubts about their legitimacy. It is highly suspect to have results that indicate that twice as many students in Grade 7 reached the highest level of critical analysis as those in Grade 10. Notwithstanding these caveats, the high percentages of students classified at the lowest level of critical analysis suggests that problem situations designed to stimulate critical thinking, such as Problem 7, represent a fertile area in which teachers may enhance their methods for eliciting more thoughtful analysis in problem solving. Such problem situations may promote metacognitive actions such as selecting strategies, monitoring their implementation, making decisions, and generally, evaluating solution processes as well as answers.

Translation Problems And Process Problems

Translation problems are problems which require only selection of correct arithmetic operations followed by the necessary calculations. Such problems have been typical of those traditionally found in textbooks, more commonly called word problems. Following is an example of a translation problem:

> At a fruit stand there were 5 bunches of bananas with 4 bananas in each bunch and 3 bunches of bananas with 6 bananas in each bunch. If you bought all the bananas, and your friends ate 16 of them, how many bananas would you have left?

Solving the problem requires only selection of correct operations and calculations. In this case there are two multiplications, one addition, and one subtraction. No other general strategy is necessary.

Process problems require not only correct operations and calculations, but also the selection of a more general strategy such as guessing and testing, making a systematic list, or searching for a pattern. Following is an example of a process problem:

> In a music store tapes are sold for \$5, 10, and \$15.
> You plan to spend \$30 on tapes.
> How many different combinations of tapes could you buy?

To solve this problem simple calculations are necessary as with translation problems, but it is also necessary to make a list to try to find all possible combinations. Generally, it is useful to make a list systematic in order to decrease the risk of overlooking some items.

Only in recent years has the teaching of general problem-solving strategies received emphasis as specified in the revised British Columbia mathematics curriculum. Traditional translation problems were predominant in the past, and they were usually applications of calculation skills. Process problems have shifted the emphasis to thinking about more general ways to solve problems.

Results of Translation and Process Problems

Table 7-9 shows the comparisons of results for solving translation problems with those for problems where the guess-and-test strategy was an appropriate choice. For the several problems of each type at each grade level mean percentages of solutions for complete and correct solutions are shown.

Table 7-9.
Mean percentages of complete and correct solutions on translation problems and problems solvable by guessing and testing.

Problem Type	Grade 4	Grade 7	Grade 10
Translation	51(4)*	31(4)	52(5)
Guess and Test	22(2)	21(4)	24(2)

*Number of problems of each type in parentheses.

Table 7-9 indicates that students had considerably more success solving the translation problems than those where the strategy of guessing and testing was appropriate. This is not surprising as students have encountered far more translation problems over the years than process problems.

The lower rates of achievement on guess-and-test problems can be partly attributed to the fact that many of those problems were quite challenging. However, the more likely reason for lower performance on these problems is that a large percentage of students did not use guessing and testing. In one case, on a guess-and-test problem in Grade 7, only 4 percent of the students used guessing and testing while 36 percent attempted to solve the problem using only number operations. As noted by the Interpretation Panel, the strategy of choosing numerical operations was used excessively, and frequently inappropriately. The Panel referred to this strategy as "number grabbing," because so many students selected numbers and blindly performed calculations that were inconsistent with the conditions described in the problem statement.

Some guess-and-test problems can be solved algebraically as well. On one of those problems 22 percent of the Grade 10 students used guessing and testing, 17 percent used algebra, and 34 percent simply tried number operations. Such results suggest that much more practice with guess-and-test problems is needed, including challenging problems where the suitability of the strategy is less obvious.

Table 7-10 shows the mean percent correct for three problems where making a systematic list was an appropriate strategy. Percentages are given for complete and correct solutions (strategy implementation category 9), for students who made at least a start in the required list items (strategy implementation categories 6-9), and for students who had little or no success (strategy implementation categories 1-5) .

Table 7-10. Mean percentages of complete solutions and partial lists on 3 systematic list problems.

Solution Stage	Grade 4	Grade 7	Grade 10
Complete and Correct	14	21	24
Partial List	45	39	41
Little or No Success	41	40	35

The sharply contrasting percentages of students who obtained a complete and correct solution with those who had some understanding of the problem and made at least a start toward the complete list is typical of problems requiring a list when the list is long or when two or more lists are needed. On one extremely complex problem less than one percent of Grade 7 and Grade 10 students obtained a complete and correct answer. The complete solution required students to construct many sublists, and the lists included items which could be easily overlooked. Most disappointing was the high percentages of solutions with little or no success at each grade level. These results suggest that more attention should be given to practice in using the strategy of making a systematic list and checking carefully for completeness in the list.

Answers and Answer Statements Following Problem Solutions

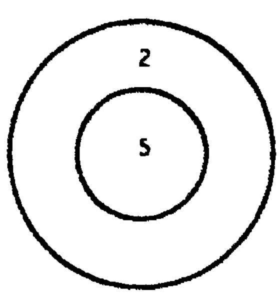
Along with identification of strategy implementation categories, answers and answer statements were classified as well. Answers were classified as correct, incorrect, undetermined or blank. Table 7-11 shows the mean percentages of problems in which the answers were classified in the four categories for each grade level.

Table 7-11. Percentages of problems in 4 answer categories.

Grade	Correct	Incorrect	Undetermined	Blank
4	35(31)*	56	2	7
7	29(24)	60	3	8
10	37(32)	47	5	11

*Percentages of correct answers with appropriate and complete solutions in parentheses.

As Table 7 -11 indicates, across grade levels, the percentages of correct answers exceeds the percentages of answers which were not only correct but were supported by complete development of appropriate strategies by about five percentage points. It is unlikely that a significant percentage of answers was obtained strictly by mental processing because of the challenging nature of the problems. A problem in Grade 4 illustrates how correct answers can sometimes be obtained without valid support. In the problem shown below numerical facts were manipulated improperly or with incomplete understanding to obtain a correct answer.



If you hit the target outside the bull's eye you score 2 points.
If you hit the target inside the bull's eye you get 5 points.
Carrie hit the target 6 times and scored 24 points.
How many times did Carrie hit the bull's eye?

On this problem 62 percent of the answers were correct, but only 37 percent of the answers were supported by appropriate and complete work. Students could get the correct answer by dividing 24 by 6 and ignoring all other relevant facts. They could also divide 24 by 5 to get 4 and a remainder which fortuitously matches the amount needed for two more hits. With different point totals, e. g. 21 points, this manipulation would not produce the correct answer. The problem accentuates the special care which must be taken to construct problems with numerical facts that are immune to obtaining correct answers without appropriate strategies and operations.

After solving a problem it is appropriate to write a statement which answers the question posed in the problem. The answer statement should include the units and contextual information which gives meaning to the numerical answer. Table 7-12 shows the percentages of students who provided complete answer statements, incomplete statements with either no units or no context, and no statement at all for problems which required an answer. At each of the three grades, one problem required only a list and is not included in the table data.

Table 7-12. Percentages of students providing complete, partial, and no answer statements.

Grade	Complete	No Units	No Context	No Statement
4	45	4	22	29
7	41	5	24	22
10	53	1	23	23

Across all three grades about one-quarter of the students failed to write any answer statement. Failure to write an answer statement may indicate that a student is crunching numbers without awareness of the problem situation. A number may be cranked out and accepted blindly as the answer with no attempt to connect it with the problem situation. When students write an answer statement, they provide added indications about their understanding of the goals of the problem. The act of writing the statement can trigger a realization that the question in the problem may have been only partly answered or that the answer is unreasonable. Such awareness helps to encourage students to look back at the solution to resolve a conflict. When students do not understand a problem or fail to complete a solution, they are less likely to write an answer statement.

Problems which require only selection of arithmetic operations followed by calculations (translation problems) are easier to understand than problems which also require the use of other strategies (process problems). Table 7-13 shows comparisons of the mean percentages of students who wrote complete answer statements for the translation problems with percentages of complete answer statements for the process problems. Table 7-13 also shows similar comparisons on translation problems and process problems for students who made no answer statement at all.

The results in Table 7-13 indicate that students provided complete answer statements in translation problems more frequently than with process problems. At the same time fewer students failed to write an answer statement with translation problems than with process problems. These results are consistent with the principal achievement results of the assessment, with students having more success with translation problems than with process problems.

Table 7-13. Mean percentages for solutions with complete answer statements and no answer statement for translation and process problems.

Grade	Complete Answer Statement		No Answer Statement	
	Translation	Process	Translation	Process
4	51	42	27	31
7	46	42	21	27
10	61	48	13	29
Mean	53	44	20	29

On the average, across all problems and across all three grade levels, about one-fourth of the solutions contained no answer statements. Grade 10 students wrote some form of answer statements for translation problems more frequently than did students at the other two grade levels, but they were just as likely as stu-

dents in the lower grade levels to omit answer statements in process problems. There was a notable exception. The problem with the highest percentage of complete answer statements was a logic problem in Grade 10:

> Tina and Lena are running and walking around a track.
> Tina runs half way and walks the other half.
> Lena runs half the time and walks half the time.
> Whenever they run, Tina and Lena run at the same speed.
> Whenever they slow down to walk, they walk at the same speed.
> Who takes less time to circle the track?
> Explain your thinking.

The problem is solved principally by using the logic that if you run half the time, you cover more than half the track. Although only 12 percent of the students had a completely correct and appropriate solution, 29 percent of the students gave the correct answer without a suitable explanation. Despite the small percentage of students who solved the problem properly, 69 percent gave a complete answer statement and only 13 percent gave no statement at all. Apparently most students thought they understood the problem situation and the problem goal although some students were mystified because the problem contains no numbers. Most students drew a diagram to help them understand the problem. It is tempting to hypothesize that this may have helped them to gain enough grasp of the problem situation and question to expedite their writing an answer statement. However, in one set of Grade 7 problems, the two problems with the lowest percentages of answer statements involved situations where drawing a diagram would be helpful. Perhaps, unless an explanation is specifically requested, many students may regard a diagram as a clear pictorial statement which makes a verbal statement superfluous.

Levels of Success in Problem Solving

Except for Category 4 (strategy not clear) in the Student Response Characterization Coding Scale, the categorizations of strategy implementation can be used to indicate levels of success in problem solving. Category 4 is inappropriate as a success indicator as it includes not only unclear strategies but a wide range of success using those strategies.

Some of the strategy implementation categories are closely related and may be combined to determine a simpler and more expedient number of levels of success in problem solving. Figure 7-10 describes five levels of success. It is reasonable to group categories 1 and 2 together as the lowest level, Level 1. Categories 7 and 8 which describe essentially correct solutions having only secondary errors can be grouped with Category 9 (correct and appropriate solution) as the highest level, Level 5, as shown in Figure 7-10.

Under these arbitrary criteria, less than half of the students across grades reached the two upper success levels. While these results may seem disappointing, they are not unexpected in view of the universality of students' difficulties in solving problems. In the Fourth National Assessment of Educational Progress in the United States (Dossey et al., 1989), less than one percent of 9-year old and 13-

Figure 7-10. Levels of problem-solving performance.

Level 1 (SRCCS categories 1 and 2)
No work shown or identifies data only. There is no representation of the problem situation and no progress toward solution.

Level 2 (SRCCS category 3)
Problem misinterpreted. The student constructs a representation of a problem situation which is erroneous. Some constructive work may be shown.

Level 3 (SRCCS category 5)
Strategy initiated but incomplete or poorly implemented. There is some understanding of the problem. A good beginning may be made but progress is halted or misconceptions prevent a good solution.

Level 4 (SRCCS category 6)
Conditions overlooked or possibilities not exhausted. There is considerable although incomplete understanding of the problem but strategy implementation falls short of solution due to failure to note all conditions or possibilities.

Level 5 (SRCCS categories 7-9)
Appropriate and complete solution or problem contains only secondary errors. There is a completely correct representation of the problem situation with a complete and correct implementation of a strategy except for errors in calculation, units, transcription, or incomplete answer statement.

year old students reached "Level 350," which "demonstrates the capacity to apply mathematical operations in a variety of problem settings" (pp. 127-128). Even among 17-year old students, only six percent reached Level 350. In this light, the percentages of students in British Columbia reaching the highest levels of problem solving are encouraging.

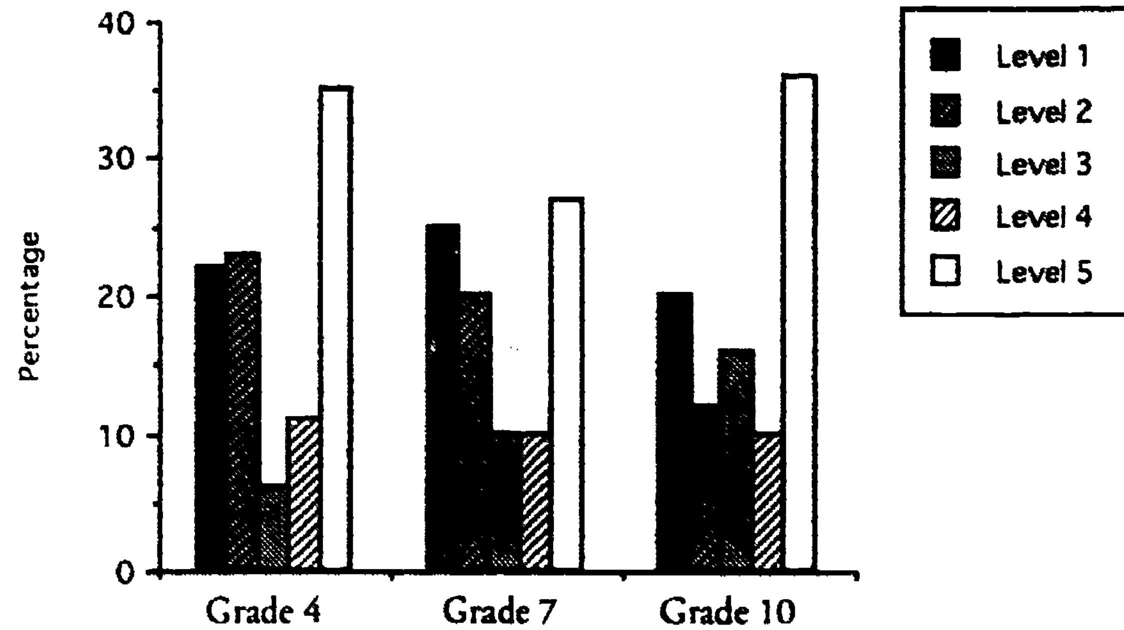
Table 7-14 shows the mean percentages of students at each level for the totality of 12 problems on the two Q-forms. Percentages do not total 100 percent as they do not include students in Category 4 (strategy not clear).

Table 7-14. Mean percentages of students reaching each level of problem solving (means of 12 problems).

Grade	Level 1	Level 2	Level 3	Level 4	Level 5
4	22	23	6	11	35
7	25	20	10	10	27
10	20	12	16	10	36

The results are also shown in bar graphs in Figure 7-11.

Figure 7-11. Levels of performance based upon strategy implementation.



The problems in this assessment were designed to be real problems where solution paths were not obvious, not simply routine problems with easy solutions. Because such problems require ability to assimilate facts and conditions as well as choose and implement an appropriate strategy, it was expected that all students would find some problems difficult and some would find all problems difficult. However, the unexpectedly high percentages at the two lowest levels are cause for concern. A fifth or more of the problem solutions were at the very lowest level with nothing more than problem facts written. At the same time the highest level was reached in the highest percentage of solutions. It appears that in problem solving two extremes predominate. Either there is very little understanding and strategy implementation or there is considerable understanding and strategy implementation with a relatively small percent of students in the middle range. The first stage of problem solving, getting to understand the problem, is so important. When students understand a problem, they are likely to have success in reaching a solution. When they do not understand a problem, they are likely to have little if any success in solving the problem. More productive methods of promoting understanding in problem solving must be found. Such methods will likely involve more student participation with discussions about problem situations and possible strategies for solution as well as student presentations of their solutions.

Relationships Between Regular and Problem-Solving Assessments

Problem solving using multiple-choice format was also investigated in the regular mathematics assessment. While higher percentages of students obtained correct answers in the regular assessment than in the open-ended problems assessment, closer observation of the results indicates general consistency rather than disparity. In the main assessment students could obtain correct answers by chance, and the open-ended problems were more challenging than those in the main assessment.

For example, in the Grade 4 main assessment, on five one-step translation problems percentages of correct answers ranged from 30 to 65 percent. On five multiple-step and multiple-conditions problems in the regular grade 4 assessment, percentages of correct answers ranged from 29 to 57 percent. In the open-ended problems in Grade 4, although three problems proved exceptionally difficult with percentages of correct answers below ten percent, the range of percentages of correct answers on the other nine problems was 24 to 64 percent.The mean percent of correct and complete solutions of the 12 more difficult open-ended problems in Grade 4 was 31 percent.

Results in the Grade 7 main assessment also support the general conclusion of how difficult students find solving problems. On each of the nine non-routine problems half or less than half of the students chose the correct answer. The difficulty in teaching as well as learning problem solving was evident from the more than 60 percent of Grade 7 teachers and 73 percent of Grade 10 teachers who identified problem solving as difficult or very difficult to teach.

With respect to gender differences the results from both the main and open-ended problems assessments are very consistent. Performances of males and females in all strands except Measurement in Grades 4 and 7 were about equal. These results are consistent with the small differences on open-ended problems in Grades 4 and 7. In Grade 10, the mean scores on items at the application or problem-solving level in the main assessment were about five percentage points higher for males than females. These results are consistent with the Grade 10 results on open-ended problems where males had margins of three and six percentage points on the two problem-solving forms.

The decline in attitudes toward problem solving from Grade 4 to Grade 10 as measured by the eight-item attitude scale in the open-ended problems forms was consistent with results on questionnaire items from the main study. Nearly 60 percent of grade 7 students reported that problem solving is easy compared to less than 40 percent of Grade 10 students. Nearly half of Grade 7 students reported that they liked problem solving compared to little more than a third of Grade 10 students.

Observations of the Interpretation Panel

Observations of the Interpretation Panel for the Grade 4, 7, and 10 problems were diverse. It was generally agreed that some problems were too wordy or contained too many facts especially in Grades 4 and 7. Because many students failed to utilize appropriate strategies and relied excessively on number crunching it was suggested that more practice with general strategies such as guessing and testing was needed. The Panel recommended more emphasis on having students show all their work, explain what they did, identify the strategy they use - in short, explain their thinking. The Panel also noted the importance of diagramming in solving problems and the need to spend more time "teaching how to diagram."

The importance of relevance of problems for students was noted. Problem situations related to hockey or to pages in a book were thought to be less in-

teresting for students than problems involving music groups or television programs.

It was observed that in a Grade 4 problem requiring a complete list in which nearly half of the students reached strategy implementation level 6 (conditions overlooked or possibilities not exhausted) only six percent provided a complete solution. It was suggested that teachers should encourage perseverance in solving problems to increase the frequency of complete solutions. In general, more problems with multiple answers were recommended.

Estimates of the expectations of success on the problems were generally lower than the actual results. For the Grade 7 problems, the Panel underestimated the percentages of students who would achieve Level 6 on strategy implementation on two problems and overestimated performance on ten problems. On one problem the estimate and actual performance were about equal. Some estimates were sharply below actual performance. On the "hockey problem" shown here where guessing and testing was an appropriate strategy, the Panel estimated that 40 percent of the students would reach at least Level 6. In fact only 15 percent reached Level 6.

> A hockey team scored 70 goals in 24 games. In 10 of the games the team scored 2 goals in each game. In the other games they scored either 3 goals or 4 goals. The team won only when they scored 4 goals. How many games did the team win?

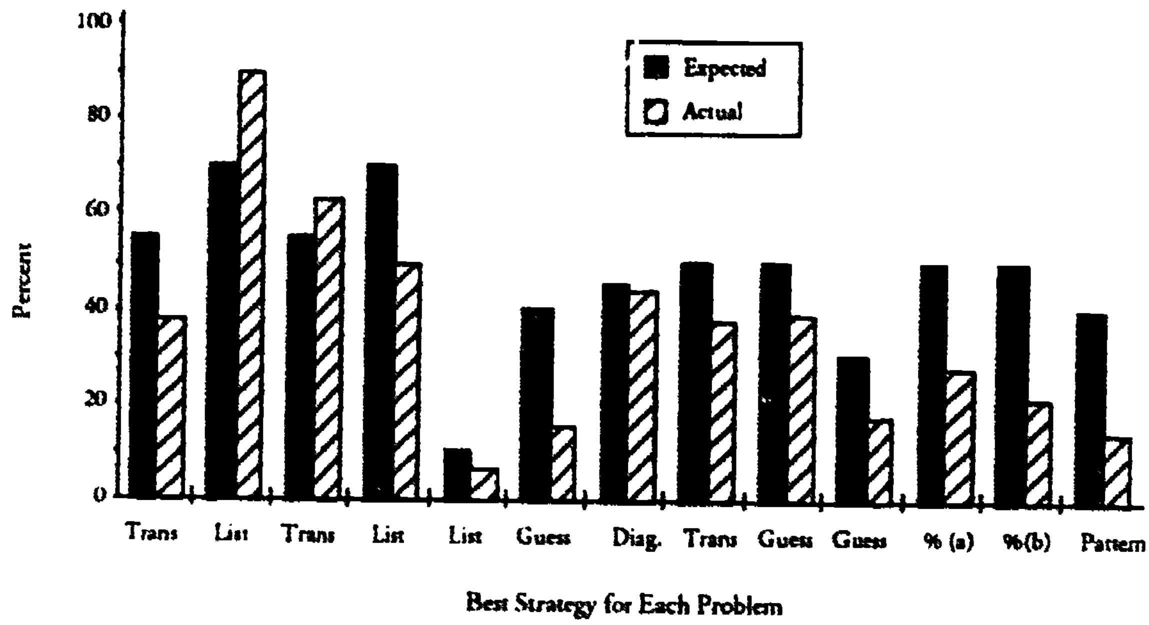
The Panel overestimated expected performance on a problem involving percent containing two questions.

> Mike, Larry, and Les earned money mowing lawns. One week Mike worked for 20 h, Larry worked for 12 h, and Les worked for 18 h.
>
> a) What percent of the total number of hours did Mike work?
>
> b) During that week the boys were paid a total of $225.
> How much of the money should Mike receive?

For each problem the Panel estimated that 50 percent of the students would reach at least Level 6. Only 27 percent of the students reached that level on Part (a) and even fewer, 21 percent reached that level on Part (b). Panel members raised concerns about the ability of Grade 7 students to solve percent problems but felt that in Grade 7, the concept of percent and applications of percent are not yet well developed.

Figure 7-12 shows the expected and actual percentages of students reaching Levels 6-9 for the 13 problems in Grade 7.

Table 7-12. Expected and actual percentages of solutions at Levels 6-9 for problems in Grade 7



Summary of Principal Results

The principal results of the assessment of problem solving in British Columbia are summarized in the following.

1. A high percentage of students in British Columbia are unable to make significant progress in solving problems. On the six problem assessment forms at the three grade levels, each containing six problems, an average of about 22 percent of the solutions contained no more than the problem facts.

2. In view of the complexity of real problems including many challenging problems in this assessment, a substantial percentage of problems, about 33 percent, showed complete and correct solutions or solutions with minor errors. Across grade levels, about 43 percent of students attained levels of satisfactory or better in solving problems.

3. At each grade level students had greater success in solving translation problems requiring only calculations than problems requiring general strategies.

4. General strategies were utilized less frequently than expected. For example, on a complex problem where the strategy of guess and test was most appropriate only four percent of the students used that strategy while 36 percent simply used numerical operations without guessing and testing. The strategy of making a systematic list was utilized more frequently when appropriate.

5. Experience and maturity contribute very significantly to success in problem solving. On six problems given to both Grade 7 and Grade 10 students the achievement of the Grade 10 students was considerably higher than that of the Grade 7 students.

6. Differences between males and females in solving problems are small or insignificant in Grades 4 and 7. In Grade 10 males had a higher percentage of complete and correct solutions on all 12 problems, but seven of the differences were less than 2 percent. On one problem there was an unexplainable anomaly with a difference of 18 percent.

7. Attitudes toward problem solving are generally positive in Grade 4, but attitudes decline by Grade 7 and deteriorate more by Grade 10.

8. There are few differences between males and females in attitudes toward problem solving. However, at all grade levels females are less positive about their ability to solve problems than boys.

9. At all grade levels very small percentages of students are able to critically analyze an already solved problem which suggests low levels of metacognitive processes such as making good decisions, monitoring strategy implementation, and checking the reasonableness of the answer.

10. Students in English-speaking classes in Grade 4 had a higher percentage of complete and correct solutions than those in French-speaking classes. In Grades 7 and 10 this result was reversed. The small sample of students in French-speaking classes makes this an observation rather than a conclusion.

11. About one-quarter of problem solutions contained no answer statements. Complete answer statements were more likely with translation problems than with process problems. Absence of any answer statement was more common on process problems than on translation problems.

12. Correct answers to problems do not necessarily indicate complete understanding. Across grades the number of correct answers was about 5 percentage points higher than correct answers supported by valid solution processes.

Recommendations Suggested by the Assessment of Problem Solving

The results do not provide definitive answers to the questions listed at the beginning of this chapter which were the bases for the assessment. However, they do provide some partial answers and valuable information useful for the planning of instruction in problem solving at all grade levels. In order for teachers to focus more clearly on areas needing special attention, these areas must be identified. Problems requiring such strategies as guessing and testing, negative attitudes toward problem solving especially in the upper grades, and weakness in metacognitive skills and critical analysis in the process of solving problems are among those areas needing increased attention.

It was not surprising that students had greater success in solving problems requiring only selection of correct operations and calculations than problems requiring more general strategies. However, it was surprising and disappointing

that the strategy of guess and test was often overlooked in problems where the strategy would have been very appropriate. When the interpretation panel noted that "number grabbing" rather than thoughtful attempts to understand problem situations was predominant, it struck the chord that probably characterizes students' attempts to solve problems more than any other factor. These observations suggest that :

1. More instructional and discussion time needs to be given to helping students to attain appropriate representations of problem situations in order to overcome blind number grabbing and to help students select more appropriate problem-solving strategies.

2. In Grades 4 and 7 more time must be devoted to problems involving general strategies. In particular more problems where the strategy of guess and check would be useful should be presented and discussed before and after solution.

3. In Grade 10 the strategy of guess and check should receive more emphasis even in algebra classes. Not only is guessing and checking useful but it leads very naturally to understanding and formulating more efficient systems of equations.

Despite the narrowing of the gap between males and females in higher-level thinking in mathematics, the fact that there were significant differences in favor of males in Grade 10 remains a concern that must be addressed. It is suggested that:

1. At all grade levels opportunities for interactive problem solving between males and females be increased. The practice of small group problem solving is becoming more common especially in the elementary grades and has excellent potential in the secondary grades.

The fact that relatively positive attitudes toward problem solving in Grade 4 deteriorate by Grade 7 and become more negative in Grade 10 suggests that:

1. More interesting problems including real-world problems should comprise a major portion of problems presented to students.

2. Students should solve problems in comfortable situations including small group problem solving.

3. Solutions to problems in which several strategies are appropriate should be presented by students to the entire class in order to increase their active participation as well as illustrate different approaches to solving the problems.

4. Teachers should be aware that females are less confident in their ability to solve problems than males. Any opportunity to

raise the self concept of females in solving problems should be utilized.

The inability of most students to evaluate an already solved problem successfully (Problem 7 on each assessment form), suggests that students take little time to examine problem-solving processes critically, do little monitoring of strategy implementation, and fail to check the reasonableness of answers. These metacognitive processes are difficult to promote, but it is recommended that:

1. Teachers occasionally use already solved problems containing errors for their students to examine critically.
2. Discussions of problems between teachers and students and among students should be promoted to provide a climate of more active thinking, more careful analysis of problem situations, more careful monitoring of strategy implementation, and evaluation of the obtained answer.

The fact that about one-quarter of the solutions had no answer statements and that complete answer statements for process problems were less frequent than for other problems suggests that:

1. Teachers should strongly encourage students to write complete answer statements for all solutions. Writing such statements gives further evidence of a student's degree of understanding of a problem. Writing an answer statement can also initiate an awareness that an answer is unreasonable or incomplete, or fails to meet all of the problem conditions.

References

Charles, R., Lester, F., & O'Daffer, P. (1987). *Problem solving: What, why, and how.* Palo Alto, California: Dale Seymour Publications.

Dossey, J. A., Mullis, I. V.S., Lindquist, M. M., & Chambers, D. L. (1988). *The mathematics report card: Are we measuring up?* Princeton, New Jersey: Educational Testing Service.

Dossey, J. A., Mullis, I. V.S., Lindquist, M. M., & Chambers, D. L. (1989). What can students do? In M. M. Lindquist, (Ed.), *Results from the Fourth Mathematics Assessment of the National Assessment of Educational Progress.* Reston, VA: National Council of Teachers of Mathematics.

Fennema, E. & Sherman, J. (1977), Sex-related differences in mathemaics achievement, spatial visualization, and affective factors. *American Educational Research Journal, 14,* 51-71.

Friedman, L. (1989). Mathematics and the gender gap: A meta-analysis of recent studies on sex differences in mathematical tasks. *Review of Educational Research, 59*(2), 185-214.

Ministry of Education (1987). *Mathematics Grades 1-8. Curriculum Guide.* Victoria: Curriculum Development Branch.

Rabijewska, B. (1981). Demonstration, decision and complementation problems and their generation. *International Journal of Mathematical, Educational, and Scientific Technology, 12*(6), 619-628.

Robitaille, D. R. & O'Shea, T.J. (Eds.) (1985). *The 1985 British Columbia Mathematics Assessment: General Report.* Victoria, B.C. Ministry of Education.

Szetela, W. (1987). The problem of evaluation in problem solving: Can we find solutions? *The Arithmetic Teacher, 35*(3), 36-41.

Whitaker, D. (1976). A study of the relationship of selected non-cognitive factors and the problem solving performance of fourth grade children. (Tech. Rep. No. 396). Madison: Wisconsin Research and Development Centre for Cognitive Learning.

Woods, Rick. (1982). An evaluation scale for problem solving in elementary grades. Unpublished paper.

Chapter 8

Conclusion

David F. Robitaille

The 1990 mathematics assessment was the fourth in a series dating back to 1977. Each one has involved the collection of enormous amounts of data from students and teachers about the teaching and learning of mathematics in the schools of the province. Each assessment provides a highly detailed snapshot of what mathematics is being taught, by whom it is being taught, and the degree to which students are able to demonstrate skills and knowledge of the prescribed content. Such information is essential to rational planning for the continued improvement of the teaching and learning of mathematics in British Columbia schools.

The report of the 1985 assessment was written in anticipation of the adoption of a long-awaited, sweeping revision of the K-12 mathematics curriculum; and several of the recommendations contained in that report (Robitaille & O'Shea, 1985) addressed specific topics or pedagogical approaches which the new curriculum should encompass. That revised curriculum was adopted in 1987, and the current assessment marks the first occasion since its adoption when it has been possible to evaluate the extent to which that curriculum has been implemented and the effects that its adoption might have had on students' achievement and attitudes.

What do the results tell us? What have we learned about the state of mathematics education in the province after testing all students at three grade levels, and collecting information from their teachers? Are there areas of the curriculum in which students demonstrate particular strength? Are there others in which there is a clear need for improvement?

The *Provincial Report* is intended to provide responses to such questions. In the first section, we highlighted a number of findings of particular importance. In subsequent sections, we identified other findings that we believe accurately reflect the state of the teaching and learning of mathematics in British Columbia. Many of those results are encouraging, but others point to areas where improvement is needed. Our report is addressed to all of the major stakeholders in mathematics education in the province: teachers, principals, consultants, district-level administrators, teacher educators, the British Columbia Association of Mathematics Teachers, and the Ministry of Education. Our hope is that the report will serve as a catalyst in the continuing process of improving the teaching and learning of mathematics in our schools.

In previous mathematics assessments, we addressed specific recommendations to individual agencies—school districts, the Ministry of Education, or the Faculties of Education, for example—regarding matters where some sort of remedial action was deemed to be warranted. For this report, we decided not to make recommendations in that formal sense. Instead, we have identified our concerns throughout the report, and suggested possible directions for improvement. We hope that everyone who has a role to play in mathematics education in this province will consider our findings and take appropriate action.

Overall, the results of the 1990 assessment demonstrate that students in the schools of British Columbia are learning a great deal of mathematics and that

the levels of performance exhibited on the assessment items were, in many cases, at or above the levels established by the interpretation panels. This finding provides confirmation of the results of previous assessments of mathematics in the province, as well as from two recent international studies in which students from British Columbia have participated (Robitaille & Garden, 1989; Lapointe, Mead, Phillips, 1989).

The assessment has also led to the identification of a number of areas in which improvement is needed, and references to those have been made throughout the report. These are the areas that, in the opinion of the members of the contract team, require special attention.

In this concluding section we identify four areas or themes that we consider to be of overarching concern. Our goal is to bring these themes to the attention of major stakeholders, in the hope that the individuals and organizations involved will recognize the importance of these matters and take appropriate action to improve the current situation. The four areas are participation of women, implementation of the revised curriculum, teaching methods, and student outcomes.

Area of Concern: Participation of Women

Only 20 percent of Grade 10 mathematics teachers are women. This finding should be a matter of concern to everyone with an interest in schools, particularly when viewed in conjunction with the negative attitudes exhibited in the responses of Grade 10 girls toward continued participation in mathematics-related studies at the postsecondary level or in mathematics-related careers. There is a shortage of female teachers to serve as role models for young women who have the ability to succeed in mathematics; and, although the participation rates of boys and girls in mathematics courses at the senior secondary levels are fairly close, the differences increase dramatically in mathematics and in some of the sciences when students enter university where, among other things, future teachers acquire their academic and professional preparation.

Postsecondary educational institutions throughout the province are aware of the fact that women are seriously under-represented in the sciences generally, and many of them have adopted programs of various kinds to address the problem. The Ministry of Advanced Education and Job Training is also aware of this problem and its implications for the future of the province. Meetings have been held to discuss the extent of the problem, and to try to identify actions to be taken to reverse this trend.

We support those initiatives, but our concern is that not enough is being done, and that the problem is not being accorded the serious attention it deserves. We believe that the Ministry of Education and the Ministry of Advanced Education and Job Training should establish a task force on women in science, with a mandate to develop programs aimed at educating young women about the importance of careers in science, including teaching. The provincial universities should set up similar task forces, and the faculties of education should develop programs to attract increasing numbers of women into teaching careers in mathematics and science at the secondary school level. Schools and school

districts, in cooperation with the British Columbia Teachers' Federation and the College of Teachers, should develop incentive programs to increase the numbers of women teaching mathematics at the secondary level.

The under-representation of women in the ranks of mathematics teachers is not a new phenomenon, and the issue has been raised in a variety of settings. One of the reasons advanced as a possible explanation for that under-representation has to do with the nature of curricula in mathematics and science, and another with the pedagogical approaches which predominate in the teaching of mathematics. There is a growing school of thought which suggests that the teaching techniques most frequently employed in the teaching of mathematics—large-group lectures and individual work on assignments by students—are not highly compatible with women's ways of knowing and learning. It has also been suggested that pedagogical practices and the content of the curriculum should place less emphasis on abstraction and give increased attention to cooperative approaches to teaching and learning.

We believe that research should be carried out in the province to investigate linkages between the content of the curriculum in mathematics and science and the under-representation of women in science-related careers, including the teaching of mathematics and science. Such a research study should be the subject of a call for proposals issued to researchers and research agencies in British Columbia and elsewhere. The study should include a thorough review of the existing literature in the field, but should also include collection of pertinent data from secondary and postsecondary students in British Columbia.

Curriculum and pedagogy are two aspects of the teaching-learning process which are amenable to change, and the importance of this issue makes it imperative that answers and solutions be sought without delay. If it is the case that the content of the mathematics curriculum and the teaching techniques which are used predominantly in mathematics classrooms are among the factors which influence young women's decisions about educational or career choices, then changes must be initiated.

Area of Concern: Implementation of the Curriculum

Initial implementation of the revised mathematics curriculum took place in 1987. Therefore, the new curriculum had been in place for at most three years when this assessment was conducted. Data from the teacher questionnaires indicate that teachers are generally supportive of the new curriculum and of the textbooks approved for use in mathematics classes. Our concern arises from the gap that seems to exist between the support in principle given to the revised curriculum and the actual implementation of that curriculum by teachers.

Teachers are professionals who are called upon daily to make decisions about what content to teach, how best to teach it, and how to adapt both content and method to the particular needs and interests of their students. For that reason, one should not be surprised to find certain differences between the intended curriculum—the curriculum as specified in the curriculum guide—and the implemented curriculum—the curriculum as taught in each classroom. However, the number of topics which teachers reported that they had not taught, and the

reasons they gave for not teaching those topics, are cause for concern. In addition, information obtained from students regarding teaching practices employed by teachers seemed to indicate that a number of important areas are either being neglected or paid insufficient attention.

Teachers reported that there was too much content in the new curriculum, and that might be a reason for not covering all of the topics in that curriculum. However, teachers also said that lack of time for teaching mathematics was not an important factor in accounting for students' lack of success in mathematics. Moreover, it seems to be the case that the amount of time teachers are devoting to the teaching of mathematics has decreased since 1985. It is difficult to make precise comparisons because the data were coded differently in 1985 than in 1990, but this finding does seem to be supported by the data. We view this as an alarming development and believe that steps should be taken to reverse the trend.

One possible explanation for this apparent decrease, especially at the elementary level, may be that teachers are devoting more class time to work on integrated themes, in which some mathematics is taught in conjunction with several other subjects in a common context. Such a trend is to be encouraged so that students come to see how mathematics is used in all aspects of life. On the other hand, the nature of mathematics requires that the curriculum be carefully structured and that topics be introduced in a well-defined sequence.

An appropriate balance between these two approaches is called for. It would be unwise to recommend that mathematics be taught in isolation from all other subjects. It would be equally unwise to think that all mathematics could be taught through integrated approaches.

Some new topics have been added to the curriculum at every grade level and others have been accorded increased emphasis in the curriculum. An example of the former is the data analysis strand which includes topics from statistics and elementary probability. An example of the latter is an increased emphasis on problem solving and teaching students how to use problem solving strategies in the solution of non-routine problems. The assessment data indicate that many of these topics are either not being taught or not being given the emphasis they deserve and require.

A possible reason for this may be that some teachers are not familiar with the new curriculum and are not making sufficient use of the curriculum guide in deciding which topics to treat and the degree of emphasis to give them. They may be relying too heavily on textbooks whose contents do not adequately reflect the topics in the curriculum guides. With all the attention that is currently being given to Year 2000 initiatives and the primary, intermediate, and graduation program documents, the prescribed curriculum guides may not be receiving the attention they deserve. Another possible explanation has to do with professional development. Many teachers were apparently unaware of any in-service opportunities in mathematics being available in their school districts, and we assume that, in at least some cases, they were probably correct in that view.

Mathematics is too important a part of the school curriculum, and the implementation of the new curriculum which has been several years in develop-

ment is too important a process to be allowed to occur in anything but a structured, organized fashion. These results indicate to us a need for high quality, professional development opportunities for teachers, with particular emphasis on those topics which are new to the curriculum and which the results of this assessment have shown to be underimplemented. All administrative levels of the school system, the faculties of education, as well as the teachers themselves and their associations, have a shared responsibility to ensure that the programs developed and adopted by the Ministry of Education are implemented as intended in the schools of the province.

Area of Concern: Teaching Methods

Students were asked to comment on the frequency with which their teachers employed a number of teaching practices. The list included whole-class instruction, quizzes and tests, seat work by individual students, teachers providing assistance to individual students, cooperative learning, and use of concrete materials. The results should be interpreted cautiously because these are data about teachers collected from students rather than from direct observation of teachers in their classrooms. However, the patterns suggested by the students' responses indicate a need for further study if not immediate action.

Research in education has shown that using concrete materials in the teaching of mathematical concepts and encouraging students to work cooperatively in small groups can result in significant improvement in students' learning and achievement. The revised curriculum guides for mathematics, on the basis of that research, encourage teachers to implement these kinds of teaching practices. Yet, the questionnaire results suggest that many teachers have not done so to any significant degree. The fact that many students express the opinion that using manipulative materials is of low importance, suggests that they believe that their teachers assign low importance to the use of concrete materials.

The use of cooperative learning groups is another pedagogical practice that seems to be used infrequently. Similarly, students' performance on the non-routine problem-solving items suggests that they may have not had much exposure to strategies for solving non-routine problems.

Area of Concern: Student Outcomes

Students in British Columbia are learning a great deal of mathematics, and the results from this assessment are encouraging overall. However, there are a number of areas where improvement is greatly to be desired, and several of these are described in the following paragraphs.

It is disconcerting to see the gradual but constant deterioration of students' attitudes toward mathematics and to the likelihood that they might pursue mathematics-related careers. The vast majority of students at all grade levels agreed with the statement that one needs to know mathematics in order to "get a good job." It is interesting to speculate about what students might have had in mind in indicating such a high degree of agreement since, on the face of it, the statement is certainly false. More disturbing, however, is the fact that almost the

same proportion of students who agree with that statement say that they would not like to have a job that required them to use mathematics. These are attitudes which our society can ill afford, and everyone connected with the teaching and learning of mathematics at any level needs to be conscious of the importance of developing positive attitudes toward the subject and the necessity of inculcating such attitudes in our students.

Students continue to have difficulty with certain topics which have traditionally had a prominent place in the curriculum. Every assessment has pointed to the difficulties students seem to have with items associated with understanding of rational number concepts and their applications. Similar difficulties are evident in the results of this assessment, and we need to search for methods of making these important ideas more accessible to students.

Geometry is another area where performance was generally below expectations. However, in this case, the level of performance seems to have more to do with the fact that some teachers are not teaching the content than with the inherent difficulty of the content. Teachers should implement the curriculum, in spirit as well as in content, and they should have access to professional development programs designed to help them do so.

Some new topics have been added to the revised curriculum, and others have been given increased emphasis. Three which deserve special mention are problem solving, estimation, and data analysis, including elementary ideas of probability. The absolute centrality of all three of these topics to the contemporary mathematics curriculum has been underscored both locally and internationally on many occasions. Yet, the assessment results show that many teachers in the province are not devoting sufficient time to them. Indeed, many teachers apparently believe that these topics are not part of the prescribed curriculum, in spite of the fact that the curriculum guide devotes a great deal of attention to them. Measures need to be taken to ensure that teachers have access to the curriculum guides as well as to textbooks and other teaching materials which will make it easier for them to include these new topics and to give them appropriate emphasis in their teaching.

References

Lapointe, A. E., Mead, N. A., & Phillips, G. W. (1989). *A World of Differences: An International Assessment of Mathematics and Science*. Princeton: Educational Testing Service.

Robitaille, D. F. & Garden, R.A. (1989). (Eds.) *The IEA Study of Mathematics II: Contexts and Outcomes of School Mathematics*. Oxford: Pergamon Press.

Robitaille, D. F. & O'Shea, T. J. (1985). *The 1985 B. C. Mathematics Assessment: Summary Report*. Victoria, B. C.: Ministry of Education.

Appendix A

Contributors to this Report

Les Dukowski is principal of Stafford Secondary School in Langley. He has been a member of the Contract Team for the last three mathematics assessments, and was a member of the research team which prepared the curriculum report for the Sullivan Royal Commission on Education. He is an author of mathematics textbooks for a major Canadian publisher.

Valerie Overgaard is the Academic Assistant to the Dean of Education at the University of British Columbia. She is presently completing a doctoral program in curriculum theory at Simon Fraser University.

David Robitaille is professor of mathematics education and head of the Department of Mathematics and Science Education at U.B.C. He has been the chairperson of the Contract Teams for all four mathematics assessments in the province to date, and was the research director for curriculum for the Sullivan Royal Commission on Education. He coordinated British Columbia participation in the Second International Mathematics Study, and has been asked to serve as International Coordinator for the Third International Mathematics and Science Study.

Thomas Schroeder is associate professor of mathematics education in the Department of Mathematics and Science Education at the University of British Columbia. He currently serves as NCTM Co-ordinator for the Executive of the BCAMT, and has been involved in evaluation projects in mathematics education in British Columbia, Alberta, and elsewhere.

Walter Szetela is associate professor of mathematics education in the Department of Mathematics and Science Education at the University of British Columbia. He has been engaged in research in areas related to calculators in school mathematics and instruction in problem solving. His research has focused on strategies, evaluation, attitudes, and verbalization in problem solving.

Alan Taylor is Director of Instruction for the Coquitlam School District with particular responsibility for curriculum and assessment in the district. He is currently serving as chairperson of the Graduation Steering Committee for the Year 2000. He is a member of the Evaluation Committee of the British Columbia Superintendents Association, and chairperson of the Professional Development Committee of the Metro Superintendents Association.

Appendix B

Committees and Review Panels

Table B-1. List of pilot Districts.

Place	School District #
Fernie	1
Cranbrook	2
Nelson	7
Vernon	22
Quesnel	28
Chilliwack	33
Abbotsford	34
Delta	37
Richmond	38
New Westminster	40
Burnaby	41
Maple Ridge	42
Powell River	47
Howe Sound	48
Prince Rupert	52
Peace River South	59
Saanich	63
Cowichan	65
Alberni	70
Courtenay	71
Campbell River	72
Terrace	88

Table B-2. Advisory Committee.

Name	Place	School District #
Bob Belcher	Sooke	62
Chuck Morrison	Campbell River	72
Wendy Swonnell	Greater Victoria	61
Hélène Sullivan	Nanaimo	68
Gilles Bonenfant	Saanich	63
Marilyn Jordan	Coquitlam	43
Mark Mahovlich	Saanich	63
Grace Fraser	Surrey	36
Amy Brydon	Courtenay	71
Dana Close	Sooke	62
Cheryl MacLeod	Surrey	36
Gladys A. Bittner	Surrey	36
Alice Zilber	Surrey	36
Mignonne Wood	Burnaby	41
Ian deGroot	North Vancouver	44
Betty Milne	Cowichan	65
Sandy Dawson	Simon Fraser University, Burnaby	
James Sherrill	University of British Columbia	
Jim Gaskill	Ministry of Education	
Vaughan Lewis	Ministry of Education (after September 1989)	
Bill Toth (Chair)	Ministry of Education	

Table B-3. Item Review Panel meeting: Richmond B.C. Thursday, May 25, 1989. List of participants.

Grade	Place	School District #
Grade 4		
Chris Guernsey	Delta	37
Norma Dechene	Richmond	38
Alan Andrews	Vancouver	39
Bob Dall	Sunshine Coast	46
Gwen Langford	Greater Victoria	61
Bev Byron	Gulf Islands	64
Liz Matthews	Nanaimo	68
Donna Parker	Qualicum	69
Neill Dixon	Courtenay	71
Leslie Anderson	Mission	75
Grade 7		
Richard Savage	Hope	32
Jim Van Meer	Abbotsford	34
Keith Enos	Langley	35
Clare Hansen	Vancouver	39
Joanne Shu'esk	Burnaby	41
Barbara Ward	Coquitlam	43
Shirley Wass	Sooke	62
Doug Alderson	Saanich	63
Bill Cleary	Cowichan	65
Allan Todd	Campbell River	72
Math 10/10A		
Pat Barrett	Surrey	36
Blair Peacock	Delta	37
Steve Taylor	Richmond	38
Louise Paulson	New Westminster	40
Phil Mendez	Burnaby	41
Steve Demos	Maple Ridge	42
Gina Thorstenson	Coquitlam	43
John Nakmoto	North Vancouver	44
Arnold Scheck	Powell River	47
Ken Floyd	Lake Cowichan	66
Barry Blair	Alberni	70
Arlene Fehr	Vancouver Island West	84
Paul Tinney	Vancouver Island North	85
Pearl Gervais	Ministry of Education	
Bill Toth	Ministry of Education	

Table B-4. Item Review Panel Meeting: Delta Lakeside Penticton, B.C. Wednesday, May 31, 1989. List of participants. Grade 4.

	Place	School District #
Contract Team Member:		
Thomas Schroeder	University of British Columbia.	
Gillian Clouthier	Richmond	38
Advisory Team Member:		
Cheryl MacLeod	Surrey	36
Teacher Panel:		
Jane Lindquist	Penticton	15
Stuart Culver	Keremeos	16
Dennis Hamaguchi	Vernon	22
Steve Leahy	Central Okanagan	23
Peter Marunchuck	Central Okanagan	23
Art Blackwell	Kamloops	24
John McLellan	Kamloops	24
Catherine Davies	Lillooet	29
Margaret Todd	South Cariboo	30
Karen Andreassen	Shuswap	89
Bill Toth	Ministry of Education	

Table B-5. Item Review Panel Meeting: Inn of the North, Prince George, B.C. Friday June 2, 1989. List of participants. Grade 7.

	Place	School District #
Contract Team Member:		
Les Dukowski	Langley	35
Advisory Team Member:		
Grace Fraser	Surrey	36
Teacher Panel:		
Rob Gallamore	Quesnel	28
Brent Steele	Bulkley Valley	54
Jan Bradley	Burns Lake	55
Dan Costain	Nechako	56
Barry Huhn	Nechako	56
Norm Williams	Prince George	57
Dave King	Prince George	57
Donna Dojack	Prince George	57
Ray Asai	Peace River North	60
Brian Stevens	Terrace	88
Bill Toth	Ministry of Education	

Table B-6. Item Review Panel Meeting: Inn of the South, Cranbrook, B.C. Monday, May 29, 1989. List of participants. Math 10/10A.

	Place	School District #
Contract Team:		
Alan Taylor	Coquitlam	43
Bill Kokoskin	North Vancouver	44
Advisory Panel Member:		
Chuck Morrison	Campbell River	72
Teacher Panel		
Richard Pinotti	Fernie	1
Jim Thompson	Cranbrook	2
Grant Stewart	Cranbrook	2
Marvin Smith	Kimberley	3
Tony Kraayvanger	Windermere	4
Ed Devries	Nelson	7
Peter Young	Castlegar	9
Gary Davidson	Arrow Lakes	10
Art Benzer	Trail	11
Keith Farnworth	Grand Forks	12
Emilie Belak	Grand Forks	12
Jeff Moss	Golden	18
Gary Lewis	Revelstoke	19
Gerry Schiavon	Creston-Kaslo	86
Bill Toth	Ministry of Education	

Table B-7. French Translation Review Panel.

Name	Place	School District #
Vaughan Lewis (Chair)	Ministry of Education	
Catherine Eberlé	Vancouver	39
Lilianne Doucet	Ministry of Education	
Gloria Gietz	Ministry of Education	
Marie-France Castex	Ministry of Education	
Stephen Long	Ministry of Education	
Bill Toth	Ministry of Education	
Régine Pasquier	Contractor	
Marilyn Jordan	Coquitlam	43
Gilles Bonenfant	Saanich	63
Edèle Bonnaig	Greater Victoria	61
Hélène Sullivan	Nanaimo	68

Table B-8. Marking. Chairs. July, 1990.

Name	Place	School District #
Bob Belcher	Sooke	62
Amy Brydon	Courtenay	71
Dana Close	Sooke	62
Ivan Johnson	Burnaby	41
Marilyn Jordan	Coquitlam	43
Jack Kinakin	Castlegar	09
Carryl Koe	Mission	75
Bill Toth	Ministry of Education	

Table B-9. Problem Solving Markers. Grade 4. July, 1990.

Name	Place	School District #
Sandy Adams	Fort Nelson	81
John Briggs	Vancouver Island North	85
Rennie Brown	Nisga'a	92
Cathy Bulger	Courtenay	71
Ron Burger	Bulkley Valley	54
Glen Carter	Fernie	1
Neil Caves	Shuswap	89
Val Charison	Central Okanagan	23
Mauri Clemons - Braun	Vancouver	39
Kate Dudley	Coquitlam	43
Carol Edy	North Vancouver	96
Keith Enns	Langley	35
Bonnie Field	Delta	37
Max Geisthardt	Cowichan	65
Bryan Hansen	Peace River North	60
Glen Kinder	Creston–Kaslo	86
Janet Madhok	Nechako	56
Parmjit Parmar	Maple Ridge	42
Dennis Richards	North Vancouver	44
Judy Robinson	Abbotsford	34
Tom Shaw	Vancouver Island West	84
Elaine Sturgeon	Penticton	15
Carla Taylor	New Westminster	40
Mirella Wessel	Kamloops	24

Table B-10. Problem Solving Markers, Grade 7. July, 1990.

Name	Place	School District #
Bruce Anderson	Nechako	56
Robert Bardot	Central Okanagan	23
Lynn Broman	Vancouver	39
Ray Brunelle	North Vancouver	44
Bob Campbell	Greater Victoria	61
Judy Devereaux	Coquitlam	43
Susan Diewert	Richmond	38
Katalin Duval	Langley	35
Chris Hogarth	Campbell River	72
Dan Jorgensen	Abbotsford	34
Arthur MacNeil	Trail	11
Reusse Manfred	North Thompson	26
Margaret McDonough	West Vancouver	45
Donna McLean	Penticton	15
Al McRitchie	Surrey	36
Terry Molnar	Cranbrook	2
Bruce Murray	Kamloops	24
Bob Peacock	Terrace	88
Bill Rudyk	Revelstoke	19
Nevenka Salapura	Campbell River	72
Charles Schellinck	Golden	18
Philip Sorensen	Alberni	70
Dean Watson	Cariboo-Chilcotin	27
Norman Williams	Prince George	57

Table B-11. Problem Solving Markers, Grade 10. July, 1990.

Name	Place	School District #
Jo-Anne Aura	Peace River South	59
Barry Blair	Alberni	70
Gordon Burleson	Vancouver Island North	85
Dan Dobrinsky	Quesnel	28
Keith Farnworth	Grand Forks	12
Bonnie Fuller	Prince George	57
Lori Giacometti	Cariboo-Chilcotin	27
George Hawkins	Kettle Valley	13
Peter Isman	Vernon	22
Ameer Khan	Qualicum	69
Ed Klette	Chilliwack	33
John Livam	South Cariboo	30
Tony McCrory	Nanaimo	68
Jeff Moss	Golden	18
Wendy Mundie	Bulkley Valley	54
Frank Perehudoff	Castlegar	9
Allan Rasnysseb	Merritt	31
Keith Robertson	Cowichan	65
Naida Schulz	Central Coast	49
Steve Tarasoff	Nelson	7
Stella Tossell	Vancouver	39
Rich Tschritter	Greater Victoria	61
Andy Wong	Gulf Islands	64
Pamela Yates	Burnaby	41

Table B-12. Problem Solving Markers, French. July, 1990.

Name	Place	School District #
Gaétan Dupont	Surrey	36
Lain Martin	Central Okanagan	23
Monica Rott	Cariboo-Chilcotin	27
Judy Toy	Coquitlam	43
Marc Tremblay	West Vancouver	45

Table B-13. Interpretation Panel, Grade 4. July, 1990.

Name	Place	Status
Anne Boyd	Campbell River (# 72)	Teacher
Marilyn Bueckert	Mission (# 75)	Teacher
Joy Davidson	West Vancouver	Parent
Darryl Guza	Penticton (# 15)	Teacher
Dennis Hamaguchi	Vernon (# 22)	Chair
Dan Hudy	Cranbrook (# 2)	Teacher
Wendy Lee	North Vancouver (# 44)	Teacher
Peter Lock	Powell River (# 47)	Teacher
Colleen Lougheed	Victoria	University
Judy McLeod	Delta (# 37)	Teacher
Linda Moir	Langley (# 35)	Trustee
Susan Richardson	Kamloops (# 24)	Teacher
Susan Vlismas	Coquitlam (# 43)	Teacher
Debbie Watteyne	Lillooet (# 29)	Teacher

Table B-14. Interpretation Panel, Grade 7. July, 1990.

Name	Place	Status
Dave Bradley	Richmond (# 38)	Teacher
Steve Cairns	Burnaby (# 41)	Teacher
Kim Doerksen	Chetwynd	Parent
Colin Green	Greater Victoria (# 61)	Teacher
June McClure	Nechako (# 56)	Teacher
Freda O'Sullivan	Sooke (# 62)	Chair
Valerie Peterson	Nelson (# 7)	Teacher
Jerald Reed	Maple Ridge (# 42)	Teacher
Jim Sherrill	U.B.C.	University
Lynn Skriyc	Port McNeill	Trustee
Karen Susheski	Surrey (# 36)	Teacher
Dean Watson	Cariboo-Chilcotin (# 27)	Teacher
Douglas Wiebe	Central Okanagan (# 23)	Teacher
Norman Williams	Prince George (# 57)	Teacher

Table B-15. Interpretation Panel, Math 10. July, 1990.

Name	Place	Status
Hedwig Braunwarth	Cowichan (# 65)	Teacher
Donald Caskey	Grand Forks (# 12)	Teacher
Catherine Eberlé	Vancouver (# 39)	Chair
David Ellis	Vancouver (# 39)	Teacher
Ken Harper	West Vancouver	University
John MacMaster	Trail (# 11)	Teacher
Mark Mahovlich	Saanich (# 63)	Co-ordinator
Peggy Matheson	Burnaby (# 41)	Teacher
Rose Paszty	Castlegar	Parent
Lorne Peter	Vernon (# 22)	Teacher
Heidi Robinson	Abbotsford (# 34)	Teacher
John Runke	Nanaimo (# 68)	Teacher
Sally Sadler	Richmond (# 38)	Teacher
Evelyn Voykin	Castlegar (# 9)	Trustee
Alice Zilber	Surrey (# 36)	Chair

Table B-16. Interpretation Panel, French. July, 1990.

Name	Place	Grade	Status
John Breland	Central Okanagan (# 23)	4	Teacher
Gaétan Dupont	Surrey (# 36)	10	Teacher
Simone Dupont	Coquitlam (# 43)	4	Teacher
Catherine Eberlé	Vancouver (# 39)	10	Chair
Claudine Le Goff	Greater Victoria (# 61)	7	Teacher
Vaughan Lewis	Ministry of Education		Co-ordinator

Table B-17. Interpretation Panel, Math 10A. September, 1990.

Name	Place	School District #
Barry Blair	Alberni	70
Mark Mahovlich	Saanich	63
Peggy Matheson	Burnaby	41
Tom Poulton	Delta	37
Keith Robertson	Cowichan	65
John Runke	Nanaimo	68
Stella Tossell	Vancouver	39

Table B-18. Interpetation Panel. September 21, 1990. Open-Ended Problems. Q Forms.

Name	Place	School District #
Bob Belcher	Sooke	62
Lynn Broman	Vancouver	39
Bob Campbell	Greater Victoria	61
Judy Devereaux	Coquitlam	43
Kate Dudley	Coquitlam	43
Keith Enns	Langley	35
Bonnie Field	Delta	37
Max Geisthardt	Cowichan	65
Dan Jorgensen	Abbotsford	34
Ed Klette	Chilliwack	33
Carryl Koe	Delta	37
Tony McCrory	Nanaimo	68
Margaret McDonough	North Vancouver	44
Dennis Richards	North Vancouver	44
Keith Robertson	Cowichan	65
Carla Taylor	New Westminster	40
Stella Tossell	Vancouver	39
Richard Tschritter	Greater Victoria	61
Pamela Yates	Burnaby	41
Dana Close	Ministry of Education	
Amy Brydon	Ministry of Education	
Bill Toth	Ministry of Education	

Table C-1. Oportunity to Learn items: Grade 4.

Topic or Strand	Item number on test booklet.	Percentage of teachers saying 61–100% would get the item correct.	Percentage of teachers saying the content had not been taught.	*p*-value on item.
Place Value	(A4)	57	4	0.46
Place Value	(A4)	62	4	0.61
Place Value	(A8)	24	48	0.46
Place Value	(B1)	78	1	0.48
Place Value	(B3)	59	3	0.54
Place Value	(D4)	37	14	0.40
Place Value	(B10)	40	27	0.55
No. Operations	(B14)	29	18	0.71
No. Operations	(A18)	28	28	0.45
No. Operations	(A14)	58	16	0.21
No. Operations	(A13)	29	48	0.31
No. Operations	(A11)	75	6	0.62
No. Operations	(B16)	47	10	0.30
No. Operations	(C14)	35	35	0.51
No. Operations	(B13)	67	3	0.40
No. Operations	(C9)	43	24	0.49
No. Operations	(B18)	27	24	0.34
No. Operations	(A15)	58	26	0.61
No. Operations	(A17)	38	12	0.57
Patterns	(A7)	35	29	0.50
Dec. Fractions	(A21)	30	54	0.26
Dec. Fractions	(C20)	28	57	0.22
Dec. Fractions	(B22)	18	68	0.43
Dec. Fractions	(C22)	23	47	0.70
Dec. Fractions	(B21)	25	47	0.44
Com. Fractions	(B24)	66	23	0.68
Com. Fractions	(B25)	9	76	0.26
Com. Fractions	(B25)	9	76	0.26
Com. Fractions	(D27)	25	52	0.46
Com. Fractions	(A24)	29	61	0.31
Com. Fractions	(A26)	41	22	0.47
Data Analysis	(D28)	39	40	0.43
Data Analysis	(A30)	28	47	0.33
Data Analysis	(C21)	51	31	0.47
Data Analysis	(B28)	47	31	0.38
Data Analysis	(A29)	17	53	0.25
Data Analysis	(A28)	68	24	0.75
Geometry	(A32)	56	24	0.81
Geometry	(A31)	68	22	0.85
Geometry	(B32)	44	35	0.78
Geometry	(A31)	68	22	0.85
Geometry	(B32)	44	35	0.78
Geometry	(B33)	29	67	0.17
Geometry	(A33)	38	33	0.41
Geometry	(B30)	25	64	0.35
Geometry	(D34)	48	31	0.61
Geometry	(D36)	25	51	0.37
Geometry	(C33)	34	48	0.41
Geometry	(C36)	55	46	0.67
Measurement	(A37)	44	31	0.43
Measurement	(B36)	71	12	0.64
Measurement	(D39)	35	44	0.38
Measurement	(A36)	45	28	0.49
Measurement	(A39)	26	46	0.36
Measurement	(C35)	43	41	0.38
Measurement	(A38)	66	14	0.68
Measurement	(D35)	39	43	0.59
Number sense	(B40)	23	38	0.46
Number sense	(C19)	6	76	0.21
Number sense	(D19)	8	71	0.18

Table C-2. Oportunity to Learn items: Grade 7.

Topic or Strand	Item number on test booklet.	Percentage of teachers saying 61–100% would get the item correct.	Percentage of teachers saying the content had not been taught	p-value on item.
Expressions	(A4)	47	13	0.12
Com. Fractions	(B8)	52	11	0.42
[illegible] Fractions	(A10)	37	14	0.37
[illegible] Fractions	(A8)	38	5	0.62
Mental Skills	(A5)	32	6	0.51
Ratio	(A13)	32	31	0.36
Ratio	(B13)	67	5	0.62
Ratio	(D15)	50	22	0.67
Percent	(A14)	53	23	0.52
Percent	(C14)	39	36	0.49
Percent	(D14)	34	28	0.46
Factors	(C6)	43	7	0.47
Exponents	(D4)	32	16	0.29
Multiples	(D3)	21	16	0.47
Integers	(D16)	32	57	0.56
Integers	(A16)	43	56	0.78
Integers	(C18)	29	75	0.23
Integers	(C16)	51	46	0.57
Integers	(C17)	36	57	0.57
Integers	(B16)	77	25	0.64
Integers	(B17)	24	70	0.23
Data Analysis	(C22)	53	40	0.67
Data Analysis	(D23)	8	88	0.26
Data Analysis	(B23)	27	42	0.26
Data Analysis	(B20)	35	40	0.67
Data Analysis	(A22)	26	66	0.64
Data Analysis	(C20)	27	63	0.35
Data Analysis	(A21)	27	73	0.45
Data Analysis	(B23)	32	44	0.26
Data Analysis	(B21)	68	27	0.67
Data Analysis	(C21)	24	49	0.53
Data Analysis	(D20)	28	60	0.74
Geometry	(B26)	41	32	0.54
Geometry	(C30)	11	75	0.30
Geometry	(C29)	14	71	0.36
Geometry	(D30)	27	53	0.36
Geometry	(B30)	19	62	0.36
Geometry	(A30)	38	48	0.46
Geometry	(A28)	18	53	0.45
Geometry	(A25)	49	49	0.62
Geometry	(D29)	38	48	0.42
Measurement	(C33)	44	17	0.35
Measurement	(A35)	29	11	0.37
Measurement	(D33)	44	10	0.31
Measurement	(B32)	74	4	0.77
Measurement	(B33)	38	12	0.35
Measurement	(D31)	51	11	0.68
Measurement	(D32)	40	10	0.68
Measurement	(B35)	25	20	0.29
Measurement	(A33)	48	5	0.52
Algebra	(C36)	56	27	0.61
Algebra	(B38)	65	38	0.64
Algebra	(B37)	46	34	0.57
Algebra	(C39)	55	23	0.73
Algebra	(D38)	41	33	0.69
Algebra	(A38)	29	41	0.51
Algebra	(D37)	80	17	0.74
Algebra	(A40)	59	22	0.45
Number sense	(A20)	34	24	0.36

Table C-3. Oportunity to Learn items: Grade 10.

Topic or Strand	Item number on test booklet.	Percentage of teachers saying 61–100% would get the item correct.	Percentage of teachers saying the content had not been taught.	*p* value on item.
Calculators	(A2)	38	20	0.35
Rate	(B4)	50	5	0.61
Rate	(D1)	51	32	0.68
Exponents	(A23/B/C/D21)	79	2	0.77
Exponents	(A23/B/C/D21)	71	1	0.77
Fractions	(A/B/C/D3)	70	1	0.53
Fractions	(A41)	35	21	0.41
Radicals	(A42)	40	13	0.48
Radicals	(B42/D42)	41	17	0.60
Data Analysis	(B5)	76	18	0.31
Data Analysis	(C30)	62	33	0.71
Data Analysis	(A31)	39	27	0.32
Data Analysis	(C/D5)	48	32	0.34
Data Analysis	(A30)	51	32	0.58
Data Analysis	(A32)	64	11	0.66
Data Analysis	(C32)	66	27	0.35
Probability	(A6/B6/C7/D7)	16	57	0.59
Probability	(A6/B6/C7/D7)	17	58	0.59
Probability	(A/B/C/D44)	17	54	0.62
Probability	(A/B/C/D44)	17	53	0.62
Geometry	(B10)	57	22	0.72
Geometry	(A/B/C/D11)	54	7	0.56
Geometry	(A34)	30	56	0.17
Geometry	(A46)	29	30	0.32
Geometry	(D45)	41	22	0.43
Geometry	(A52)	35	32	0.57
Geometry	(D52)	54	31	0.70
Geometry	(C9)	52	23	0.68
Geometry	(A/B/C/D11)	59	6	0.56
Geometry	(A36/D35)	29	58	0.20
Geometry	(C46)	54	11	0.67
Geometry	(B49)	40	31	0.56
Geometry	(B52)	33	32	0.54
Measurement	(A/B/C14/D13)	49	11	0.44
Measurement	(B13)	27	14	0.42
Measurement	(A/B/C14/D13)	50	10	0.44
Measurement	(B16)	22	18	0.58
Measurement	(C37)	70	5	0.44
Measurement	(D38)	36	17	0.44
Algebra	(C19)	49	7	0.66
Algebra	(A/B/C/D17)	60	4	0.45
Algebra	(A/B/C/D17)	59	3	0.45
Algebra	(A59)	39	19	0.63
Algebra	(B59)	36	12	0.56
Algebra	(D60)	41	26	0.49

Grade 4 Tables

Table D-1. Percentage correct by strand, topic, and overall, by form.

Strand and Topic	Form A	Form B	Form C	Form D	Total
Number & Operations	52	52	51	51	52
Number Concepts & Numeration	55	56	60	57	57
Whole Number Operations	57	56	54	54	55
Decimals	41	46	37	40	41
Fractions	46	42	44	42	43
Data Analysis	44	49	44	47	46
Geometry	58	54	62	62	59
Lines, Plane Figures, Coordinates	41	27	--	66	45
Solid Figures	69	79	75	79	74
Relations and Transformations	--	58	53	49	53
Measurement	45	48	40	52	46
Length	69	64	37	48	54
Area	36	39	39	38	38
Volume and Capacity	49	47	50	51	49
Mass	29	--	22	70	41
Time, Temperature, Money	44	43	54	--	47
Number sense	19	46	21	18	26
TOTAL	51	51	50	51	51

Table D-2. Details of changes in achievement.

Strand and Topic	1990 Assessment Item Number	1990 Assessment Percent Correct	1985 Assessment Item Number	1985 Assessment Percent Correct
Number & Operations	12 items	61	12 items	61
Numeration	5 items	71	5 items	73
Numeration	B02	70	R2	72
Numeration	C01	69	S2	85
Numeration	C03	75	R3	72
Numeration	C04	56	R34	51
Numeration	D01	87	S4	85
Whole Number Operations	4 items	60	4 items	62
Operations	A16	66	T47	58
Operations	B12	71	T3	84
Operations	B13	40	S31	44
Operations	C11	62	R29	63
Rational Numbers	3 items	46	3 items	35
Fractions	C25	57	R17	64
Decimals	A20	44	T46	22
Decimals	D22	37	T45	19
Data Analysis	2 items	60	2 items	63
Data Analysis	D29	65	R19	66
Data Analysis	C29	54	S48	60
Geometry	5 items	63	5 items	61
Lines	D31	61	S38	72
Solid Figures	C31	68	S36	60
Relations	B31	58	T40	56
Relations	C36	67	R40	68
Relations	D34	61	T35	47
Measurement	6 items	44	6 items	54
Length	B36	64	R10	76
Length	C39	37	S46	45
Area	D39	38	T24	59
Volume	D35	59	S17	82
Mass	C38	22	R6	23
Temperature	A37	44	T11	41
TOTAL	25 items	57	25 items	59

Table D-3. Percentage correct by topic, strand, and overall by response to Form A question 12: "The teacher shows us what to do on the blackboard or overhead projector."

Strand and Topic	Frequently[a]	Seldom[b]	All Students[c]
Number & Operations	55	49	52
Number Concepts & Numeration	57	51	55
Whole Number Operations	59	53	57
Decimals	43	37	41
Fractions	48	43	46
Data Analysis	47	41	44
Geometry	62	56	58
Lines, Plane Figures, Coordinates	45	38	41
Solid Figures	73	68	69
Relations and Transformations	–	–	–
Measurement	50	45	45
Length	75	68	69
Area	40	35	36
Volume and Capacity	53	49	49
Mass	32	26	29
Time, Temperature, Money	47	43	44
Number sense	19	20	19
TOTAL	54	48	51

[a] Percent correct for students who responded that the classroom practice occurred "almost every day" or "often."
[b] Percent correct for students who responded that the classroom practice occurred "rarely" or "never."
[c] Percent correct for all students, regardless of their response to the classroom practice item.

Table D-4. Percentage correct by topic, strand, and overall by response to Form A question 13: "We use objects like blocks, counters, and geoboards."

Strand and Topic	Frequently	Seldom	All Students
Number & Operations	49	55	52
Number Concepts & Numeration	51	57	55
Whole Number Operations	52	59	57
Decimals	39	43	41
Fractions	44	48	46
Data Analysis	41	46	44
Geometry	57	62	58
Lines, Plane Figures, Coordinates	39	44	41
Solid Figures	69	73	69
Relations and Transformations	–	–	–
Measurement	44	49	45
Length	64	75	69
Area	37	38	36
Volume and Capacity	49	54	49
Mass	27	31	29
Time, Temperature, Money	42	47	44
Number sense	21	19	19
TOTAL	48	54	51

Table D-5. Percentage correct by topic, strand, and overall by response to Form A question 14: "We work individually on problems or other exercises the teacher assigns."

Strand and Topic	Frequently	Seldom	All Students
Number & Operations	55	48	52
Number Concepts & Numeration	57	49	55
Whole Number Operations	60	52	57
Decimals	44	37	41
Fractions	49	43	46
Data Analysis	47	39	44
Geometry	61	57	58
Lines, Plane Figures, Coordinates	44	40	41
Solid Figures	73	68	69
Relations and Transformations	–	–	–
Measurement	50	43	45
Length	75	67	69
Area	40	34	36
Volume and Capacity	55	44	49
Mass	32	26	29
Time, Temperature, Money	48	42	44
Number sense	19	20	19
TOTAL	54	47	51

Table D-6. Percentage correct by topic, strand, and overall by response to Form B question 12: "We use calculators."

Strand and Topic	Frequently	Seldom	All Students
Number & Operations	47	55	52
Number Concepts & Numeration	50	59	56
Whole Number Operations	49	59	56
Decimals	42	49	46
Fractions	38	45	42
Data Analysis	44	53	49
Geometry	53	58	54
Lines, Plane Figures, Coordinates	27	28	27
Solid Figures	77	86	79
Relations and Transformations	54	63	58
Measurement	45	53	48
Length	60	71	64
Area	37	43	39
Volume and Capacity	44	52	47
Mass	–	–	–
Time, Temperature, Money	41	49	43
Number sense	41	49	46
TOTAL	47	55	51

Table D-7. Percentage correct by topic, strand, and overall by response to Form B question 13: "We have quizzes or tests."

Strand and Topic	Frequently	Seldom	All Students
Number & Operations	54	50	52
Number Concepts & Numeration	57	53	56
Whole Number Operations	57	53	56
Decimals	47	44	46
Fractions	43	41	42
Data Analysis	51	48	49
Geometry	57	55	54
Lines, Plane Figures, Coordinates	28	26	27
Solid Figures	84	81	79
Relations and Transformations	61	60	58
Measurement	52	48	48
Length	69	63	64
Area	44	36	39
Volume and Capacity	50	48	47
Mass	–	–	–
Time, Temperature, Money	47	46	43
Number sense	47	46	46
TOTAL	54	50	51

Table D-8. Percentage correct by topic, strand, and overall by response to Form B question 14: "We review our homework and discuss the solutions."

Strand and Topic	Frequently	Seldom	All Students
Number & Operations	54	52	52
Number Concepts & Numeration	57	56	56
Whole Number Operations	57	55	56
Decimals	47	47	46
Fractions	43	42	42
Data Analysis	51	52	49
Geometry	57	56	54
Lines, Plane Figures, Coordinates	28	28	27
Solid Figures	84	82	79
Relations and Transformations	61	61	58
Measurement	52	51	48
Length	69	66	64
Area	43	40	39
Volume and Capacity	51	50	47
Mass	–	–	–
Time, Temperature, Money	47	48	43
Number sense	47	48	46
TOTAL	54	53	51

Table D-9. Percentage correct by topic, strand, and overall by response to Form C question 12: "We work in small groups."

Strand and Topic	Frequently	Seldom	All Students
Number & Operations	50	56	51
Number Concepts & Numeration	58	64	60
Whole Number Operations	53	59	54
Decimals	37	40	37
Fractions	43	49	44
Data Analysis	44	51	44
Geometry	63	69	62
Lines, Plane Figures, Coordinates	–	–	–
Solid Figures	77	82	75
Relations and Transformations	54	60	53
Measurement	41	47	40
Length	38	44	37
Area	38	46	39
Volume and Capacity	53	56	50
Mass	22	26	22
Time, Temperature, Money	56	60	54
Number sense	21	23	21
TOTAL	50	55	50

Table D-10. Percentage correct by topic, strand, and overall by response to Form C question 13: "We use computers."

Strand and Topic	Frequently	Seldom	All Students
Number & Operations	51	54	51
Number Concepts & Numeration	59	63	60
Whole Number Operations	54	57	54
Decimals	37	39	37
Fractions	44	47	44
Data Analysis	45	48	44
Geometry	64	67	62
Lines, Plane Figures, Coordinates	–	–	–
Solid Figures	78	80	75
Relations and Transformations	55	58	53
Measurement	43	44	40
Length	40	41	37
Area	40	42	39
Volume and Capacity	53	55	50
Mass	23	25	22
Time, Temperature, Money	58	58	54
Number sense	21	21	21
TOTAL	51	54	50

Table D-11. Percentage correct by topic, strand, and overall by response to Form C question 14: "The teacher helps individual students."

Strand and Topic	Frequently	Seldom	All Students
Number & Operations	53	52	51
Number Concepts & Numeration	60	60	60
Whole Number Operations	55	55	54
Decimals	38	38	37
Fractions	45	44	44
Data Analysis	47	45	44
Geometry	65	65	62
Lines, Plane Figures, Coordinates	–	–	–
Solid Figures	79	79	75
Relations and Transformations	56	55	53
Measurement	43	43	40
Length	40	41	37
Area	41	41	39
Volume and Capacity	54	52	50
Mass	24	24	22
Time, Temperature, Money	58	57	54
Number sense	21	22	21
TOTAL	52	52	50

Table D-12. Percentage correct by topic, strand, and overall by response to Form D question 12: "We work in small groups."

Strand and Topic	Frequently	Seldom	All Students
Number & Operations	51	55	51
Number Concepts & Numeration	57	60	57
Whole Number Operations	54	58	54
Decimals	41	43	40
Fractions	43	46	42
Data Analysis	47	52	47
Geometry	65	67	62
Lines, Plane Figures, Coordinates	69	71	66
Solid Figures	82	84	79
Relations and Transformations	52	53	49
Measurement	55	59	52
Length	52	55	48
Area	40	45	38
Volume and Capacity	55	58	51
Mass	75	79	70
Time, Temperature, Money	–	–	–
Number sense	19	17	18
TOTAL	53	56	51

Table D-13. Percentage correct by topic, strand, and overall by response to Form D question 13: "We use computers."

Strand and Topic	Frequently	Seldom	All Students
Number & Operations	52	54	51
Number Concepts & Numeration	58	60	57
Whole Number Operations	54	57	54
Decimals	41	42	40
Fractions	42	45	42
Data Analysis	48	51	47
Geometry	65	67	62
Lines, Plane Figures, Coordinates	69	71	66
Solid Figures	82	84	79
Relations and Transformations	52	54	49
Measurement	56	57	52
Length	51	53	48
Area	41	43	38
Volume and Capacity	57	57	51
Mass	76	76	70
Time, Temperature, Money	–	–	–
Number sense	18	17	18
TOTAL	53	55	51

Table D-14. Percentage correct by topic, strand, and overall by response to Form D question 14: "The teacher helps individual students."

Strand and Topic	Frequently	Seldom	All Students
Number & Operations	52	51	51
Number Concepts & Numeration	59	57	57
Whole Number Operations	55	54	54
Decimals	41	40	40
Fractions	44	42	42
Data Analysis	46	47	47
Geometry	66	66	62
Lines, Plane Figures, Coordinates	70	71	66
Solid Figures	83	83	79
Relations and Transformations	53	52	49
Measurement	56	56	52
Length	52	50	48
Area	42	41	38
Volume and Capacity	56	56	51
Mass	75	75	70
Time, Temperature, Money	–	–	–
Number sense	19	18	18
TOTAL	54	53	51

APPENDIX E

Grade 4 Student Achievement Items

GRADE 4 STUDENT ACHIEVEMENT SURVEY

1.1 B 5. Which numbers come next?

750, 775, 800, __, __.

30 A) 805, 810

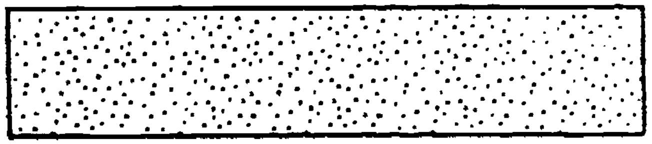
3 B) 810, 820

22 C) 825, 850

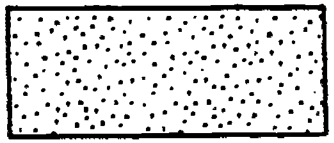
1 D) 900, 1000

4 E) I don't know.

1.3 C 5. There are 400 polka dots on this piece of cloth.



Estimate how many there are on this piece of cloth.



28 A) Between 250 and 400 dots

3 B) More than 400 dots

62 C) Between 100 and 249 dots

4 D) Less than 100 dots

3 E) I don't know.

1.1 D 3. One more than 67799 is

14 A) 667991

65 B) 67800

13 C) 167799

4 D) 67798

5 E) I don't know.

1.2 A 7. Fill in the squares by continuing the patterns horizontally and vertically. What number belongs in $\boxed{X}$?

60	63	66	
55	58	61	
50	53	56	
			X

12 A) 69

8 B) 45

51 C) 54

8 D) 59

20 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
16 A) 0 - 20%	4 A) It was done in a previous school year.
31 B) 21 - 40%	63 B) It was done during this school year.
28 C) 41 - 60%	11 C) It will be done later this year.
14 D) 61 - 80%	9 D) It will be done in a subsequent year.
11 E) 81 - 100%	11 E) It will not be done for reasons not listed here.

1.2 B 2. Which one of the following is an odd number?

9 A) 38

70 B) 45

6 C) 42

8 D) 36

6 E) I don't know.

1.1 A 1. 2000 + 700 + 40 + 8 is the same as

82 A) 2748

2 B) 2784

3 C) 7248

1 D) 8472

2 E) I don't know.

1.3 A 2. 2858 is less than

20 A) 2568

5 B) 2858

58 C) 2885

13 D) 2586

3 E) I don't know.

1.3 A 3. Which of these numbers is greater than 13 225 and less than 14 085?

8 A) 13 085

66 B) 13 800

7 C) 14 098

11 D) 14 201

8 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer this item correctly? Mark only one.
8 A) 0 - 20%	4 A) It was done in a previous school year
11 B) 21 - 40%	91 B) It was done during this school year
24 C) 41 - 60%	1 C) It will be done later this year
38 D) 61 - 80%	3 D) It will be done in a subsequent year
23 E) 81 - 100%	1 E) It will not be done for reasons not listed here

1.3 A 4. What number is one thousand more than 39 934?

31 A) 139 934

46 B) 40 934

12 C) 40 034

4 D) 38 934

8 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer this item correctly? Mark only one.
3 A) 0 - 20%	4 A) It was done in a previous school year
19 B) 21 - 40%	92 B) It was done during this school year
30 C) 41 - 60%	2 C) It will be done later this year
40 D) 61 - 80%	2 D) It will be done in a subsequent year
14 E) 81 - 100%	4 E) It will not be done for reasons not listed here

1.3 A 5. Which one of these numbers has twice as many hundreds as ones?

8 A) 4318

25 B) 8341

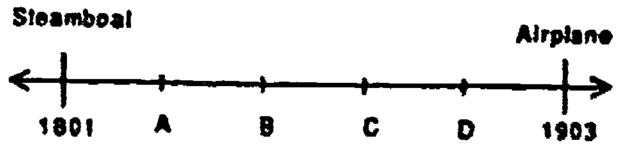
13 C) 4831

28 D) 3814

24 E) I don't know.

1.3 A 8. The bicycle was invented about 1839. About where should 1839 be placed on this timeline?

Dates of Important Inventions



9 A) Point A

45 B) Point B

26 C) Point C

7 D) Point D

11 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer this item correctly? Mark only one.
10 A) 0 - 20%	5 A) It was done in a previous school year.
23 B) 21 - 40%	47 B) It was done during this school year.
37 C) 41 - 60%	20 C) It will be done later this year.
19 D) 61 - 80%	17 D) It will be done in a subsequent year.
4 E) 81 - 100%	11 E) It will not be done for reasons not listed here

1 3 B 1. The value of the digit 3 in the number 23 091 is

11 A) 3

13 B) 300

48 C) 3 000

10 D) 30 000

19 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
1 A) 0 - 20%	2 A) It was done in a previous school year
4 B) 21 - 40%	94 B) It was done during this school year
17 C) 41 - 60%	3 C) It will be done later this year
43 D) 61 - 80%	0 D) It will be done in a subsequent year
34 E) 81 - 100%	1 E) It will not be done for reasons not listed here

1.3 B 3. Round 1368 to the nearest hundred

9 A) 1300

30 B) 1370

54 C) 1400

3 D) 2000

2 E) I don't know

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
3 A) 0 - 20%	1 A) It was done in a previous school year
17 B) 21 - 40%	95 B) It was done during this school year
26 C) 41 - 60%	F C) It will be done later this year
40 D) 61 - 80%	1 D) It will be done in a subsequent year
19 E) 81 - 100%	1 E) It will not be done for reasons not listed here

1.3 B 4. What number goes in the box to make this a true sentence?

573 = 400 + $\boxed{}$ + 3

6 A) 17

51 B) 170

4 C) 117

26 D) 70

12 E) I don't know

1.3 C 1. Which one of the following numbers says four thousand two hundred sixty-five?

20 A) 42 065

1 B) 5 624

9 C) 40 265

69 D) 4 265

1 E) I don't know.

1.3 C 2. 30 000 + 700 + 80 + 4 is the same as

27 A) 3 784

8 B) 37 084

9 C) 307 084

54 D) 30 784

7 E) I don't know

1.3 C 3 Which one of the following is the smallest number that can be made using all the digits 4, 3, 9, 1?

9 A) 1934

5 B) 1439

75 C) 1349

4 D) 1943

6 E) I don't know.

1.3 C 4 Find the missing number.
3 tens + 12 ones = $\boxed{}$ tens + 2 ones

4 A) 2

56 B) 4

10 C) 3

9 D) 1

21 E) I don't know.

1.3 D 1. Which one of the following equals 5 thousands + 8 tens + 6 ones?

87 A) 5 086

4 B) 50 086

2 C) 50 806

4 D) 5 000 806

2 E) I don't know.

1.3 D 2 The value of the digit 8 in the number 78 432 is

2 A) 8 ones.

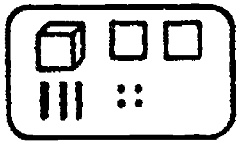
6 B) 8 hundreds.

66 C) 8 thousands.

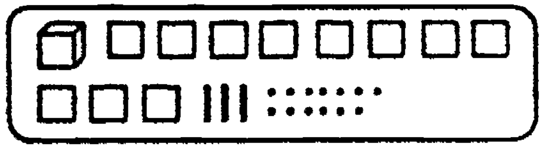
18 D) 8 ten thousands.

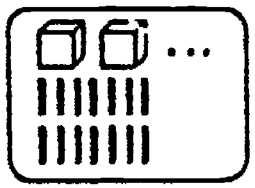
8 E) I don't know.

1.3 D 4. Which loop does not contain blocks that represent 2143?

40 A) 

13 B) 

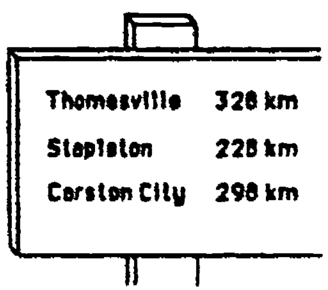
13 C) 

11 D) 

21 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
11 A) 0 - 20%	21 A) It was done in a previous school year.
28 B) 21 - 40%	65 B) It was done during this school year.
27 C) 41 - 60%	3 C) It will be done later this year.
23 D) 61 - 80%	1 D) It will be done in a subsequent year.
11 E) 81 - 100%	10 E) It will not be done for reasons not listed here

1.3 D 5. Which two cities are about the same distance away?



12 A) Thomasville and Stapleton

30 B) Stapleton and Carston City

46 C) Thomasville and Carston City

5 D) All three cities are about the same distance away.

6 E) I don't know

1.4 A 8. Add: 678 + 9 + 34 =

2 A) 901

4 B) 991

3 C) 621

84 D) 721

6 E) I don't know.

1.4 A 9. In this exercise, 4 is the

4 A) divisor.

5 B) dividend.

10 C) quotient.

71 D) remainder.

9 E) I don't know.

```
   122
6) 736
   6
   13
   12
    16
    12
     4
```

1.4 A 10. In 6 x 8 = 48, which is the product?

9 A) 6

17 B) x

11 C) 8

55 D) 48

8 E) I don't know.

1.4 A 11. Which of the following is not equal to 36?

7 A) 9x4

11 B) 3x3x4

63 C) 4x8

9 D) 3x2x6

7 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer this item correctly? Mark only one.
2 A) 0 - 20%	2 A) It was done in a previous school year.
6 B) 21 - 40%	92 B) It was done during this school year
17 C) 41 - 60%	3 C) It will be done later this year.
40 D) 61 - 80%	1 D) It will be done in a subsequent year.
35 E) 81 - 100%	2 E) It will not be done for reasons not listed here

1.4 A 12. Multiply: 9 000 x 6 =

- 7 A) 15 000
- 4 B) 5 400
- 71 C) 54 000
- 11 D) 9 006
- 7 E) I don't know.

1.4 A 13. Ian solved the division exercise shown below. What should you do to check his work by another method?

```
   103
 4)413
   4
   01
    0
    13
    12
     1
```

- 12 A) Add 1 to 103 then multiply by 4
- 8 B) Add 4 and 1 then multiply by 103
- 16 C) Multiply 413 by 4 then add 1
- 31 D) Multiply 103 by 4 then add 1
- 33 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
25 A) 0 - 20%	1 A) It was done in a previous school year
19 B) 21 - 40%	53 B) It was done during this school year
26 C) 41 - 60%	35 C) It will be done later this year
23 D) 61 - 80%	9 D) It will be done in a subsequent year
7 E) 81 - 100%	4 E) It will not be done for reasons not listed here

1.4 A 14. Find the missing digit.

$$\begin{array}{r} 4\ 5\ 7 \\ -\ 2\ \square\ 9 \\ \hline 2\ 0\ 8 \end{array}$$

- 49 A) 5
- 22 B) 4
- 22 C) 0
- 4 D) 6
- 2 E) I don't know

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer this item correctly? Mark only one.
6 A) 0 - 20%	6 A) It was done in a previous school year
17 B) 21 - 40%	79 B) It was done during this school year
29 C) 41 - 60%	5 C) It will be done later this year
33 D) 61 - 80%	4 D) It will be done in a subsequent year
16 E) 81 - 100%	7 E) It will not be done for reasons not listed here

1.4 A 15. Smith's department store wanted to buy 4596 pairs of jeans from the factory. The factory had already made 2798. How many more do they need to make for Smith's?

To solve this problem using a calculator, which buttons would you press?

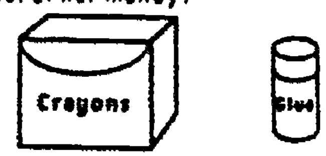
- 12 A) [C] [4] [5] [9] [6] [+] [2] [7] [9] [8] [=]
- 61 B) [C] [4] [5] [9] [6] [-] [2] [7] [9] [8] [=]
- 8 C) [C] [4] [5] [9] [6] [÷] [2] [7] [9] [8] [=]
- 5 D) [C] [4] [5] [9] [6] [x] [2] [7] [9] [8] [=]
- 14 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
6 A) 0 - 20%	5 A) It was done in a previous school year.
11 B) 21 - 40%	59 B) It was done during this school year.
24 C) 41 - 60%	19 C) It will be done later this year.
35 D) 61 - 80%	7 D) It will be done in a subsequent year.
23 E) 81 - 100%	9 E) It will not be done for reasons not listed here

1.4 A 16. Yesterday, Belle the whale ate a total of 98 fish in three meals. She ate 32 fish at the first meal and 25 fish at the second meal. How many fish did she eat for her third meal?

- 5 A) 66
- 66 B) 41
- 9 C) 155
- 12 D) 57
- 7 E) I don't know.

1.4 A 17. The prices for crayons and for glue are shown below. Katie has $2.50. If she buys 3 boxes of crayons, what is the greatest number of sticks of glue she can buy with the rest of her money?



50¢ 40¢

- 7 A) 6
- 57 B) 2
- 17 C) 3
- 9 D) 5
- 9 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
6 A) 0 - 20%	7 A) It was done in a previous school year
18 B) 21 - 40%	84 B) It was done during this school year.
38 C) 41 - 60%	7 C) It will be done later this year
31 D) 61 - 80%	3 D) It will be done in a subsequent year
8 E) 81 - 100%	2 E) It will not be done for reasons not listed here

1.4 A 18. **Schools have one teacher for every 22 students. Gatewood School has 33 teachers. Which of the following is the best estimate of the number of students attending Gatewood School?**

20 A) 55

46 B) 660

14 C) 3300

8 D) ~600

12 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.		Indicate whether you taught or reviewed the mathematics needed to answer this item correctly? Mark only one.	
16 A)	0 - 20%	1 A)	It was done in a previous school year
26 B)	21 - 40%	72 B)	It was done during this school year
29 C)	41 - 60%	11 C)	It will be done later this year.
24 D)	61 - 80%	14 D)	It will be done in a subsequent year
6 E)	81 - 100%	4 E)	It will not be done for reasons not listed here

1.4 B 9. **Which number sentence best describes this arrangement of rectangles?**

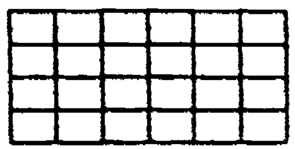
10 A) 1 x 24 = 24

6 B) 2 x 12 = 24

5 C) 3 x 8 = 24

62 D) 4 x 6 = 24

16 E) I don't know.



1.4 B 10. **In this exercise, 6 is the**

56 A) divisor.

19 B) dividend.

9 C) quotient.

8 D) remainder.

8 E) I don't know.

```
    72
6) 435
   42
    15
    12
     3
```

Estimate what percentage of the students in your class will get this item correct other than by chance		Indicate whether you taught or reviewed the mathematics needed to answer this item correctly? Mark only one.	
19 A)	0 - 20%	4 A)	It was done in a previous school year
20 B)	21 - 40%	69 B)	It was done during this school year
21 C)	41 - 60%	16 C)	It will be done later this year
23 D)	61 - 80%	6 D)	It will be done in a subsequent year
17 E)	81 - 100%	5 E)	It will not be done for reasons not listed here

1.4 B 11. **Subtract:** $\begin{array}{r} 7000 \\ -\underline{86} \end{array}$

16 A) 7086

5 B) 6900

6 C) 5024

68 D) 6914

5 E) I don't know.

1.4 B 12. **Find the product** $\begin{array}{r} 34 \\ \underline{x7} \end{array}$

11 A) 218

71 B) 238

4 C) 292

4 D) 301

9 E) I don't know.

1.4 B 13. **The answer to the subtraction exercise shown below is closest to**

$$\begin{array}{r} 5049 \\ -\underline{3892} \end{array}$$

40 A) 1000

36 B) 2000

10 C) 3000

7 D) 9000

7 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance		Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.	
3 A)	0 - 20%	3 A)	It was done in a previous school year
8 B)	21 - 40%	94 B)	It was done during this school year
23 C)	41 - 60%	2 C)	It will be done later this year.
39 D)	61 - 80%	1 D)	It will be done in a subsequent year.
29 E)	81 - 100%	1 E)	It will not be done for reasons not listed here

1.4 B 14. John is 4 years older than Ellen, and Ellen is 5 years older than Monica. Monica is 12 years old How old is John?

15 A) 10

5 B) 3

3 C) 1

22 D) 21

5 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer this item correctly? Mark only one.
13 A) 0 - 20%	3 A) It was done in a previous school year
26 B) 21 - 40%	78 B) It was done during this school year
31 C) 41 - 60%	9 C) It will be done later this year
24 D) 61 - 80%	8 D) It will be done in a subsequent year
3 E) 81 - 100%	3 E) It will not be done for reasons not listed here

1.4 B 15. Valerie and David played a game of cards. At the end of the game, Valerie's score was 3146 and David's was 5725. What is the difference in their scores?

To solve this problem using a calculator, which buttons would you press?

8 A) [C] [3] [1] [4] [6] [+] [5] [7] [2] [5] [=]

9 B) [C] [5] [7] [2] [5] [+] [3] [1] [4] [6] [=]

59 C) [C] [5] [7] [2] [5] [−] [3] [1] [4] [6] [=]

9 D) [C] [3] [1] [4] [6] [−] [5] [7] [2] [5] [=]

15 E) I don't know.

1.4 B 16 Each page in a scrapbook can hold 8 baseball cards. How many pages are needed to hold 60 baseball cards?

17 A) 7

20 B) 52

30 C) 8

21 D) 68

12 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
4 A) 0 - 20%	3 A) It was done in a previous school year
13 B) 21 - 40%	89 B) It was done during this school year
36 C) 41 - 60%	4 C) It will be done later this year
35 D) 61 - 80%	2 D) It will be done in a subsequent year
12 E) 81 - 100%	1 E) It will not be done for reasons not listed here

1.4 B 18. On the first day Joe read one page of a book, on the second day he read 2 pages, on the third day he read 4 pages, and on the fourth day he read 7 pages. If Joe continued to read the book following this pattern, how many pages did he read on the sixth day?

9 A) 32

9 B) 31

34 C) 13

34 D) 16

13 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
19 A) 0 - 20%	3 A) It was done in a previous school year.
23 B) 21 - 40%	73 B) It was done during this school year
32 C) 41 - 60%	9 C) It will be done later this year.
20 D) 61 - 80%	9 D) It will be done in a subsequent year
7 E) 81 - 100%	6 E) It will not be done for reasons not listed here

1.4 C 8. When you count by 7's, starting with 0, which one of these numbers would you not say?

5 A) 14

4 B) 21

72 C) 34

9 D) 42

4 E) I don't know.

1.4 C 9 50 × 80 = 4000, so

13 A) 50 ÷ 80 = 4000

17 B) 50 ÷ 4000 = 80

9 C) 80 ÷ 4000 = 50

50 D) 4000 ÷ 80 = 50

11 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
7 A) 0 - 20%	2 A) It was done in a previous school year.
16 B) 21 - 40%	74 B) It was done during this school year
33 C) 41 - 60%	14 C) It will be done later this year
30 D) 61 - 80%	6 D) It will be done in a subsequent year
14 E) 81 - 100%	3 E) It will not be done for reasons not listed here

1.4 C 11. Subtract: 5806
$-\underline{2438}$

<u>62</u> A) 3368

6 B) 3372

13 C) 3378

12 D) 3432

7 E) I don't know.

1.4 C 12. Smith's department store wanted to buy 4596 pairs of jeans from the factory. The factory had already made 2798. How many more do they need to make for Smith's?

To solve this problem you would

22 A) add.

<u>63</u> B) subtract.

7 C) multiply.

4 D) divide.

3 E) I don't know.

1.4 C 13. Mark's garden has 84 rows of cabbages. There are 57 cabbages in each row. Which of the following gives the best way to estimate how many cabbages there are in all?

3 A) 100 x 50 = 5000

28 B) 80 x 50 = 4000

<u>42</u> C) 80 x 60 = 4800

7 D) 90 x 60 = 5400

15 E) I don't know.

1.4 C 14. Brenda had 356 pennies. Before taking them to the bank, she put as many of them as she could into rolls. She put 50 pennies into each roll. How many pennies were not put into rolls?

<u>51</u> A) 6

13 B) 7

23 C) 306

4 D) 406

8 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
15 A) 0 - 20%	7 A) It was done in a previous school year.
20 B) 21 - 40%	63 B) It was done during this school year.
30 C) 41 - 60%	22 C) It will be done later this year.
26 D) 61 - 80%	18 D) It will be done in a subsequent year.
9 E) 81 - 100%	3 E) It will not be done for reasons not listed here.

1.4 C 15. John is 4 years older than Ellen, and Ellen is 11 years younger than Monica. Monica is 12 years old. How old is John?

<u>50</u> A) 5

6 B) 27

36 C) 15

3 D) 19

4 E) I don't know.

1.4 C 16. What two numbers are missing in this pattern?

96, 48, 24, ___, ___, 3

13 A) 16, 8

10 B) 14, 7

18 C) 18, 9

<u>40</u> D) 12, 6

19 E) I don't know.

1.4 C 18. I counted 44 wheels on the vehicles in the parking lot at the Fairbanks golf course. The only vehicles in the parking lot were cars with 4 wheels and golf carts with 3 wheels. How many golf carts and how many cars could have been parked there?

11 A) 10 golf carts and 2 cars

15 B) 2 golf carts and 10 cars

15 C) 6 golf carts and 6 cars

<u>35</u> D) 4 golf carts and 8 cars

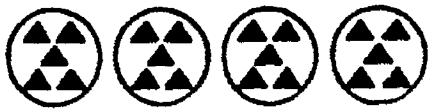
23 E) I don't know.

1.4 D 8. **Which picture illustrates the number sentence 3 x 5 = 5 + 5 + 5?**

51 A) 

13 B) 

10 C) 

12 D) 

13 E) I don't know.

1.4 D 9. In 4 x 7 = 28, the number 28 is called

41 A) the product.

13 B) the factor.

26 C) the sum.

13 D) the quotient.

6 E) I don't know.

1.4 D 11. Find the sum: 3163 + 9578

2 A) 13 100

77 B) 12 741

7 C) 12 631

8 D) 13 741

6 E) I don't know

1.4 D 12. Multiply: 96 x 100 =

3 A) 96

13 B) 960

58 C) 9 600

18 D) 96 000

7 E) I don't know.

1.4 D 13 Multiply: 576 x 0 =

20 A) 576

1 B) 1

4 C) 5760

74 D) 0

1 E) I don't know.

1.4 D 14. Dan had 125 hockey cards. At recess, he got some more. When he counted the cards at lunch, he had 180. How many did he get at recess?

9 A) 305

17 B) 65

65 C) 55

4 D) 205

5 E) I don't know.

1.4 D 15 The Grade 4 class made 240 pieces of fudge for a candy sale. They packed 6 pieces in each bag. How many bags did they need?

27 A) 60

4 B) 4

13 C) 24

41 D) 40

15 E) I don't know.

1.4 D 18. Round each number to the nearest 100, then estimate the difference.

4736−2570=☐

15 A) 2200

15 B) 2000

26 C) 2100

18 D) 2170

25 E) I don't know

1.4 D 18. Kyle and Bob are playing a game. The object of the game is to get the highest point total. This chart shows how many points they each scored in the first four rounds. Who is ahead and by how many points?

SCORE CARD		
Player	Kyle	Bob
Round 1	125	100
Round 2	125	125
Round 3	150	100
Round 4	50	150
Round 5		
Total		

10 A) Kyle is ahead by 175 points.

21 B) Bob is ahead by 100 points.

13 C) Kyle is ahead by 25 points.

46 D) Bob is ahead by 25 points.

9 E) I don't know.

1.5 A [illegible]. 6 tenths =

41 A) 6.0

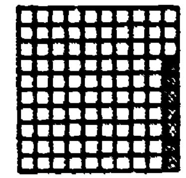
46 B) 0 6

6 C) 0.06

2 D) 0 006

6 E) I don't know.

1.5 A 21. Which decimal fraction represents the shaded part of this figure?



18 A) 7

22 B) 0.07

26 C) 0.7

16 D) 7.100

13 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer this item correctly? Mark only one.
37 A) 0 - 20%	1 A) It was done in a previous school year.
17 B) 21 - 40%	46 B) It was done during this school year
16 C) 41 - 60%	35 C) It will be done later this year
19 D) 61 - 80%	17 D) It will be done in a subsequent year
11 E) 81 - 100%	2 E) It will not be done for reasons not listed here

1.5 A 22. Choose the open number sentence which would help you solve the following problem.

Tim estimated he would need 5.5 L of pop for a party. He already had 2.5 L. Including Tim, 10 children were going to be at the party. How much more pop did he need?

46 A) 5.5 − 2.5=☐

8 B) 10 − 5.5=☐

18 C) 2.5 + 5.5=☐

7 D) 10 − 2.5=☐

19 E) I don't know.

1.5 A 23 Mrs. Smith had 94.10 m of ribbon in her florist shop. After completing all her orders, she had used 24.85 m of ribbon. How much ribbon did Mrs. Smith have left?

46 A) 69 25 m

14 B) 69 35 m

12 C) 70.25 m

13 D) 70 75 m

14 E) I don't know.

1.5 B 19. What fraction of the picture is shaded?

12 A) 0.03

61 B) 0.3

5 C) 0.7

14 D) 3.0

8 E) I don't know.

1.5 B 21. Christine and Julia were competing in a gymnastics meet. Christine scored 8.65 on the balance beam. The difference between the girls' scores was 0.17. What was Julia's score if she scored more points than Christine?

15 A) 8.48

6 B) 8.52

18 C) 8.72

44 D) 8.82

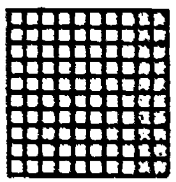
15 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
22 A) 0 - 20%	1 A) It was done in a previous school year.
23 B) 21 - 40%	53 B) It was done during this school year.
38 C) 41 - 60%	36 C) It will be done later this year.
20 D) 61 - 80%	9 D) It will be done in a subsequent year.
5 E) 81 - 100%	2 E) It will not be done for reasons not listed here

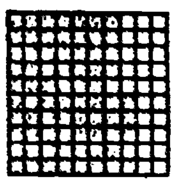
1.5 B 22. Which of the following diagrams represents a decimal between 0.25 and 0.65?

A) 8

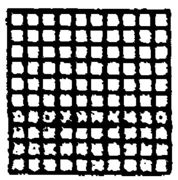
B) 8



C) 18



D) 44



20 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
47 A) 0 - 20%	1 A) It was done in a previous school year.
17 B) 21 - 40%	32 B) It was done during this school year.
18 C) 41 - 60%	42 C) It will be done later this year.
12 D) 61 - 80%	20 D) It will be done in a subsequent year
6 E) 81 - 100%	5 E) It will not be done for reasons not listed here

1.5 C 20. What place value does the 9 in 0.29 represent?

42 A) Ones

24 B) Tenths

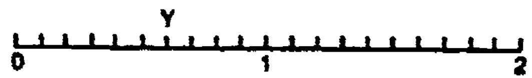
22 C) Hundredths

4 D) Thousandths

8 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
38 A) 0 - 20%	1 A) It was done in a previous school year.
15 B) 21 - 40%	42 B) It was done during this school year.
19 C) 41 - 60%	41 C) It will be done later this year.
17 D) 61 - 80%	15 D) It will be done in a subsequent year.
10 E) 81 - 100%	2 E) It will not be done for reasons not listed here

1.5 C 22. What number is represented by point Y on the number line?



5 A) 1.3

21 B) 0.6

5 C) 0.3

10 D) 0.06

8 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
23 A) 0 - 20%	3 A) It was done in a previous school year.
18 B) 21 - 40%	52 B) It was done during this school year.
26 C) 41 - 60%	25 C) It will be done later this year.
23 D) 61 - 80%	19 D) It will be done in a subsequent year.
8 E) 81 - 100%	2 E) It will not be done for reasons not listed here

1.5 C 23. In a relay race, Dan's time was 4.8 seconds. Gary's time was 5.3 seconds, and Jim's was 5.45 seconds. What was their total time?

27 A) 6.48 seconds

26 B) 14.55 seconds

9 C) 15.5 seconds

29 D) 15.55 seconds

9 E) I don't know.

1.5 D 20. 0.40 is the same as

5 A) four.

49 B) four tenths.

7 C) four hundredths.

34 D) forty tenths.

5 E) I don't know.

1.5 D 22. Add:

$$\begin{array}{r} 0.6 \\ 0.8 \\ +0.9 \\ \hline \end{array}$$

4 A) 0.023

44 B) 0.23

32 C) 2.3

10 D) 23

3 E) I don't know.

1.5 D 23. Andy wanted to buy some nuts for his recess snack. Walnuts, his favourite, cost \$2.32 for 100 g. Peanuts cost \$1.50 for 100 g, and almonds cost \$1.75 for 100 g. For 100 g of nuts, how much more would the walnuts cost than the peanuts?

9 A) \$0.57

42 B) \$0.82

19 C) \$1.22

9 D) \$2.82

14 E) I don't know.

1.6 A 24. $\frac{78}{100}$ is the same as

31 A) 78.0

6 B) 7.8

31 C) 0.78

21 D) 0.078

9 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
31 A) 0 - 20%	9 A) It was done in a previous school year.
19 B) 21 - 40%	43 B) It was done during this school year
21 C) 41 - 60%	39 C) It will be done later this year.
18 D) 61 - 80%	17 D) It will be done in a subsequent year.
10 E) 81 - 100%	3 E) It will not be done for reasons not listed here

1.6 A 25. What fraction of the shapes is shaded?

10 A) $\frac{3}{6}$

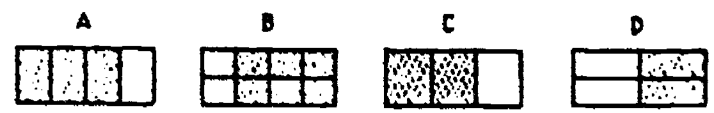
6 B) $\frac{2}{3}$

68 C) $\frac{3}{9}$

4 D) $\frac{6}{9}$

10 E) I don't know

1.6 A 26. Which two diagrams show equivalent fractions?



42 A) A and B

20 B) C and D

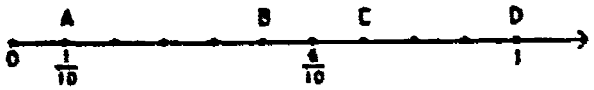
6 C) B and C

14 D) A and D

11 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
19 A) 0 - 20%	3 A) It was done in a previous school year
18 B) 21 - 40%	70 B) It was done during this school year
27 C) 41 - 60%	21 C) It will be done later this year.
28 D) 61 - 80%	5 D) It will be done in a subsequent year
13 E) 81 - 100%	2 E) It will not be done for reasons not listed here

1.6 A 27. Which letter on this number line represents the fraction that is $\frac{1}{10}$ more than $\frac{6}{10}$?



8 A) A

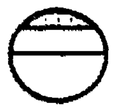
19 B) B

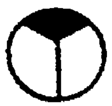
31 C) C

13 D) D

20 E) I don't know.

1.6 B 24. Which one of the following pictures represents the fraction $\frac{1}{3}$?

6 A) 

16 B) 

3 C) 

70 D) 

4 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer this item correctly? Mark only one.
8 A) 0 - 20%	7 A) It was done in a previous school year
10 B) 21 - 40%	71 B) It was done during this school year
17 C) 41 - 60%	19 C) It will be done later this year.
28 D) 61 - 80%	3 D) It will be done in a subsequent year
38 E) 81 - 100%	1 E) It will not be done for reasons not listed here

1.6 B 25 Andrea delivered $\frac{3}{4}$ of her party invitations by hand. Then she had 5 left to mail. How many invitations did she deliver by hand?

26 A) 5

18 B) 10

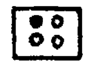
28 C) 15

8 D) 20

20 E) I don't know

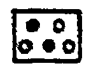
Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
56 A) 0 - 20%	1 A) It was done in a previous school year
23 B) 21 - 40%	23 B) It was done during this school year
13 C) 41 - 60%	33 C) It will be done later this year.
7 D) 61 - 80%	36 D) It will be done in a subsequent year.
2 E) 81 - 100%	7 E) It will not be done for reasons not listed here

1.6 C 25 Which one of the following groups of dots is one-half ($\frac{1}{2}$) shaded?

30 A) 

32 B) 

21 C) 

3 D) 

6 E) I don't know.

1.6 C 27 Three lines are related as follows:

Line X is twice as long as line Y.

Line Z is $\frac{1}{2}$ as long as line Y.

Which line is the shortest?

9 A) X

20 B) Y

44 C) Z

15 D) There is no shortest line

10 E) I don't know.

1.6 D 25. In the fraction $\frac{2}{3}$ the number on the bottom is the

14 A) dividend.

20 B) numerator.

6 C) multiplicand.

40 D) denominator.

19 E) I don't know.

1.6 D 27. Tom has a collection of toy cars. He has 5 blue ones, 7 green ones, and 3 red ones. What fraction of his collection is green?

11 A) $\frac{7}{10}$

45 B) $\frac{7}{15}$

23 C) $\frac{7}{8}$

5 D) $\frac{8}{7}$

9 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance			Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.		
33	A)	0 - 20%	7	A)	It was done in a previous school year
19	B)	21 - 40%	41	B)	It was done during this school year
21	C)	41 - 60%	30	C)	It will be done later this year.
20	D)	61 - 80%	18	D)	It will be done in a subsequent year
6	E)	81 - 100%	3	E)	It will not be done for reasons not listed here

2.1 A 29. Barbara is going to make a pictograph using the information shown below. She is going to use the book symbol to make her graph.

SYMBOL

BOOKS READ

Allan	40
Bev	15
Carl	20
Donna	35
Frank	60
George	15
Susan	65

A reasonable number of books for each symbol to represent is

9 A) 1

25 B) 10

22 C) 20

17 D) 100

24 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance			Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.		
35	A)	0 - 20%	6	A)	It was done in a previous school year
22	B)	21 - 40%	33	B)	It was done during this school year
26	C)	41 - 60%	39	C)	It will be done later this year.
13	D)	61 - 80%	14	D)	It will be done in a subsequent year
5	E)	81 - 100%	8	E)	It will not be done for reasons not listed here

2.1 C 28. If the symbol  is used to represent 100 trucks on a chart, then the symbols

would represent

38 A) $3\frac{1}{2}$ trucks.

4 B) 35 trucks.

4 C) 300 trucks.

42 D) 350 trucks.

5 E) I don't know.

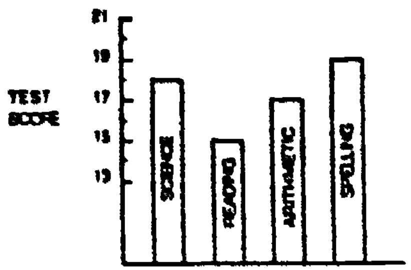
Estimate what percentage of the students in your class will get this item correct other than by chance			Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.		
11	A)	0 - 20%	9	A)	It was done in a previous school year
14	B)	21 - 40%	61	B)	It was done during this school year.
24	C)	41 - 60%	22	C)	It will be done later this year.
33	D)	61 - 80%	5	D)	It will be done in a subsequent year
18	E)	81 - 100%	3	E)	It will not be done for reasons not listed here

2.1 D 29. Leslie's test scores were:

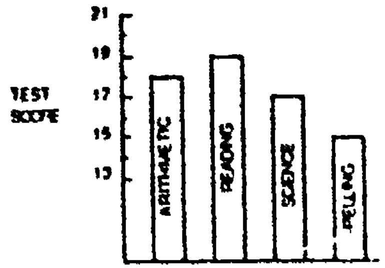
Arithmetic	18
Spelling	15
Science	17
Reading	19

Which graph shows Leslie's results?

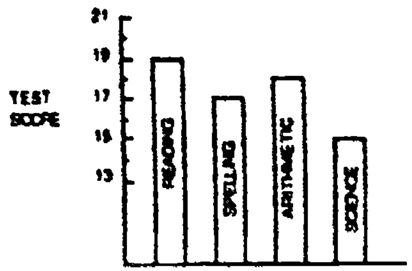
A) 7



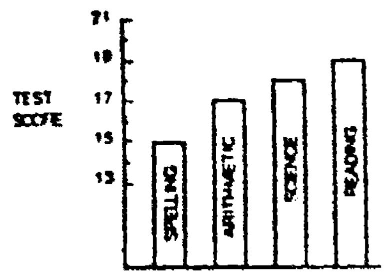
B) 65



C) 7



D) 8



10 E) I don't know

2.2 A 28. The following information shows the number of cars sold during a four day period.

Monday	~~IIII~~	IIII
Tuesday	~~IIII~~	II
Wednesday	~~IIII~~	III
Thursday	~~IIII~~	

On which day was a total of 7 cars sold?

7 A) Monday

24 B) Tuesday

10 C) Wednesday

4 D) Thursday

3 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
6 A) 0 - 20%	33 A) It was done in a previous school year
9 B) 21 - 40%	44 B) It was done during this school year
13 C) 41 - 60%	16 C) It will be done later this year
31 D) 61 - 80%	4 D) It will be done in a subsequent year
36 E) 81 - 100%	4 E) It will not be done for reasons not listed here

2.2 A 30. The list below shows the information Janice collected about the months in which the 27 students in her class had their birthdays. Which of the following questions can Janice answer using the information in this list?

July	Aug.	Sept.	Oct.	May	Feb.
June	Apr.	Dec.	Sept.	Mar.	Aug
Oct	June	Apr.	Dec.	Sept.	
June	Apr.	Dec.	Sept.	Nov.	
May	Feb	Jan.	June	Jan	

15 A) Who is the oldest student in her class?

10 B) How many students are 10 years old?

13 C) Who has a birthday in February?

33 D) Were more students in Janice's class born in January or in June?

24 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer this item correctly? Mark only one.
19 A) 0 - 20%	4 A) It was done in a previous school year.
21 B) 21 - 40%	49 B) It was done during this school year
31 C) 41 - 60%	18 C) It will be done later this year
22 D) 61 - 80%	16 D) It will be done in a subsequent year
7 E) 81 - 100%	13 E) It will not be done for reasons not listed here

2.2 B 27. Who worked a total of 5 hours on Day 4?

Working Hours

	Day 1	Day 2	Day 3	Day 4	Day 5
Mrs. A	8	5	7	6	6
Mr. B	5	8	7	5	5
Ms. C	7	6	5	7	8
Miss D	6	5	5	7	7

3 A) Miss D

9 B) Ms C

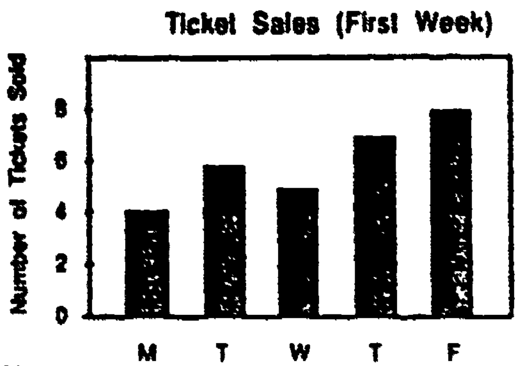
22 C) Mr B

3 D) Mrs A

6 E) I don't know

271 272

2.2 B 28. To raise money for new uniforms, a baseball team was selling raffle tickets. How many tickets did the team sell in the first week?



12 A) 60

10 B) 32

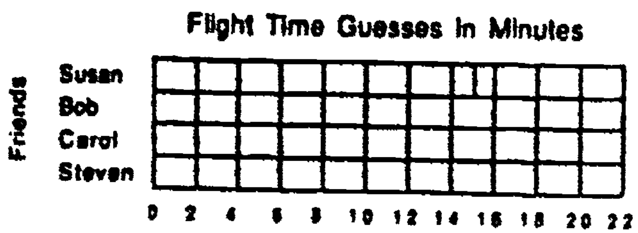
18 C) 30

22 D) 28

14 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
9 A) 0 - 20%	6 A) It was done in a previous school year.
18 B) 21 - 40%	46 B) It was done during this school year.
28 C) 41 - 60%	26 C) It will be done later this year.
31 D) 61 - 80%	4 D) It will be done in a subsequent year.
15 E) 81 - 100%	3 E) It will not be done for reasons not listed here

2.2 C 29. Pat was testing his model plane. His friends guessed how long it would stay in the air. The plane stayed up for 17 minutes. Who guessed closest to the correct time?



58 A) Carol

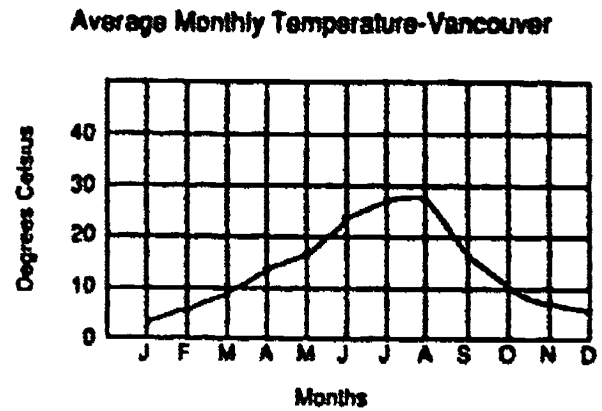
19 B) Susan

6 C) Bob

12 D) Steven

5 E) I don't know.

2.2 D 28. Which two months had the same average temperature?



19 A) January and December

20 B) February and November

5 C) March and April

42 D) May and September

11 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer this item correctly? Mark only one.
14 A) 0 - 20%	5 A) It was done in a previous school year.
19 B) 21 - 40%	35 B) It was done during this school year
27 C) 41 - 60%	22 C) It will be done later this year.
24 D) 61 - 80%	13 D) It will be done in a subsequent year.
15 E) 81 - 100%	5 E) It will not be done for reasons not listed here

3.1 D 31. Which one of the following segments is not a side of the square?

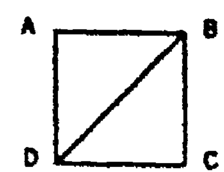
8 A) AB

6 B) BC

7 C) CD

61 D) BD

13 E) I don't know.



3.2 A 34. How many triangles are shown here?

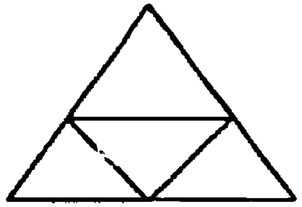
49 A) 4

39 B) 5

3 C) 3

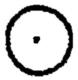
3 D) 6

1 E) I don't know.

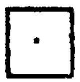


Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
9 A) 0 - 20%	7 A) It was done in a previous school year
16 B) 21 - 40%	64 B) It was done during this school year
29 C) 41 - 60%	17 C) It will be done later this year.
31 D) 61 - 80%	6 D) It will be done in a subsequent year.
18 E) 81 - 100%	6 E) It will not be done for reasons not listed here

3.2 B 33. A dog walks on a path that is always 5 m from a pole. Which of the following could be a drawing of the path?

18 A) 

6 B) 

14 C) 

42 D) 

15 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer this item correctly? Mark only one.
29 A) 0 - 20%	3 A) It was done in a previous school year
23 B) 21 - 40%	30 B) It was done during this school year
27 C) 41 - 60%	17 C) It will be done later this year
20 D) 61 - 80%	28 D) It will be done in a subsequent year
10 E) 81 - 100%	21 E) It will not be done for reasons not listed here

3.3 A 31. The solid figure shown in this drawing is called a

85 A) cone.

5 B) cylinder.

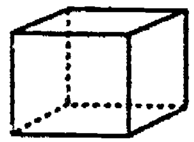
2 C) prism.

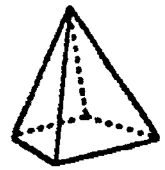
3 D) sphere.

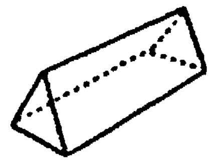
2 E) I don't know.

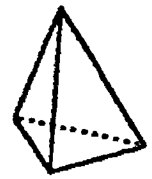
Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer this item correctly? Mark only one.
10 A) 0 - 20%	11 A) It was done in a previous school year
8 B) 21 - 40%	68 B) It was done during this school year.
15 C) 41 - 60%	16 C) It will be done later this year.
22 D) 61 - 80%	5 D) It will be done in a subsequent year.
46 E) 81 - 100%	2 E) It will not be done for reasons not listed here

3.3 A 32. Which figure has six faces?

82 A) 

3 B) 

6 C) 

3 D) 

3 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer this item correctly? Mark only one.
11 A) 0 - 20%	5 A) It was done in a previous school year
12 B) 21 - 40%	71 B) It was done during this school year
22 C) 41 - 60%	18 C) It will be done later this year.
27 D) 61 - 80%	5 D) It will be done in a subsequent year
28 E) 81 - 100%	1 E) It will not be done for reasons not listed here

3.3 A 33. How many vertices does this figure have?

12 A) 3

24 B) 5

41 C) 6

13 D) 9

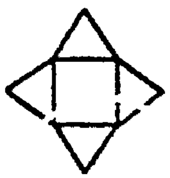
6 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.			Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.		
26	A)	0 - 20%	2	A)	It was done in a previous school year
16	B)	21 - 40%	65	B)	It was done during this school year.
21	C)	41 - 60%	19	C)	It will be done later this year.
22	D)	61 - 80%	13	D)	It will be done in a subsequent year
15	E)	81 - 100%	4	E)	It will not be done for reasons not listed here

3.3 B 32. Which of these figures can be cut out and folded to make a pyramid?

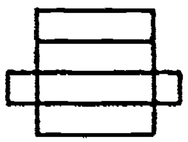
A)

28



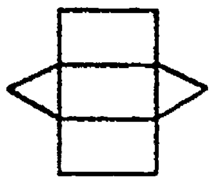
B)

3



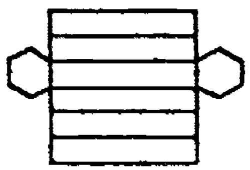
C)

8



D)

3



4 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance			Indicate whether you taught or reviewed the mathematics needed to answer this item correctly? Mark only one.		
16	A)	0 - 20%	5	A)	It was done in a previous school year
19	B)	21 - 40%	59	B)	It was done during this school year
23	C)	41 - 60%	18	C)	It will be done later this year
26	D)	61 - 80%	12	D)	It will be done in a subsequent year
18	E)	81 - 100%	5	E)	It will not be done for reasons not listed here

277

3.3 C 31. A soup can is shaped most like a

13 A) sphere.

7 B) cube.

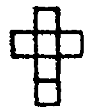
68 C) cylinder.

5 D) cone.

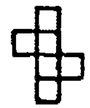
3 E) I don't know.

3.3 C 34. Which one of these figures cannot be folded to make a cube?

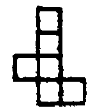
8 A)



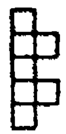
13 B)



16 C)



53 D)



6 E) I don't know.

3.4 B 31. How many pieces the same size as A are needed to cover B?

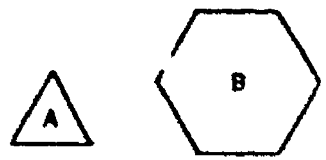
10 A) 4

11 B) 5

58 C) 6

10 D) 7

6 E) I don't know.



275

3.4 C 33. **Which one of these drawings was made by drawing a figure and then sliding it?**

24 A) 

12 B) 

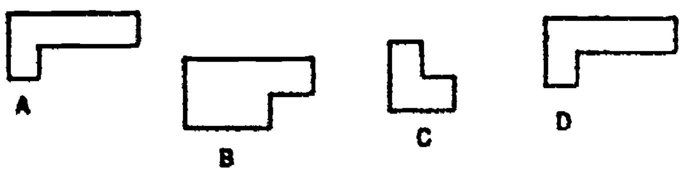
40 C) 

6 D) 

14 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
27 A) 0 - 20%	3 A) It was done in a previous school year
14 B) 21 - 40%	49 B) It was done during this school year
22 C) 41 - 60%	30 C) It will be done later this year.
22 D) 61 - 80%	10 D) It will be done in a subsequent year.
12 E) 81 - 100%	9 E) It will not be done for reasons not listed here

3.4 C 35. **Figures that are the same size and shape are congruent figures. Which of the following figures are congruent?**



5 A) A and B

42 B) A and D

7 C) C and D

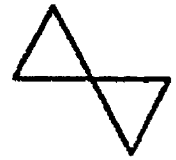
5 D) B and C

10 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
29 A) 0 - 20%	3 A) It was done in a previous school year
14 B) 21 - 40%	51 B) It was done during this school year
21 C) 41 - 60%	29 C) It will be done later this year.
23 D) 61 - 80%	12 D) It will be done in a subsequent year
22 E) 81 - 100%	5 E) It will not be done for reasons not listed here

3.4 D 36. **Which of these drawings shows a triangle that has been turned one-half turn?**

29 A) 

37 B) 

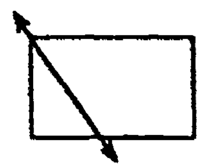
18 C) 

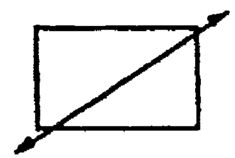
4 D) 

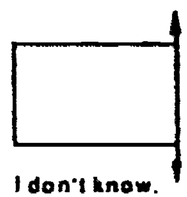
5 E) I don't know.

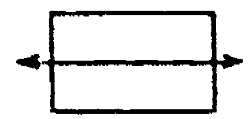
Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
34 A) 0 - 20%	2 A) It was done in a previous school year
20 B) 21 - 40%	48 B) It was done during this school year
21 C) 41 - 60%	25 C) It will be done later this year.
19 D) 61 - 80%	16 D) It will be done in a subsequent year.
7 E) 81 - 100%	9 E) It will not be done for reasons not listed here

3.6 D 34. **In which one of the following figures is the line a line of symmetry?**

5 A) 

5 B) 

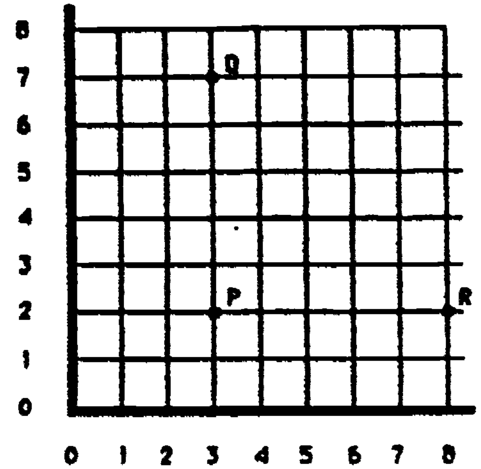
10 C) 

61 D) 

13 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
23 A) 0 - 20%	3 A) It was done in a previous school year
12 B) 21 - 40%	61 B) It was done during this school year
17 C) 41 - 60%	17 C) It will be done later this year.
23 D) 61 - 80%	10 D) It will be done in a subsequent year
25 E) 81 - 100%	3 E) It will not be done for reasons not listed here

3.7 A 35. P is the point (3, 2), Q is the point (3, 7), and R is the point (8, 2). Which two of these points are farthest apart?



14 A) P and Q

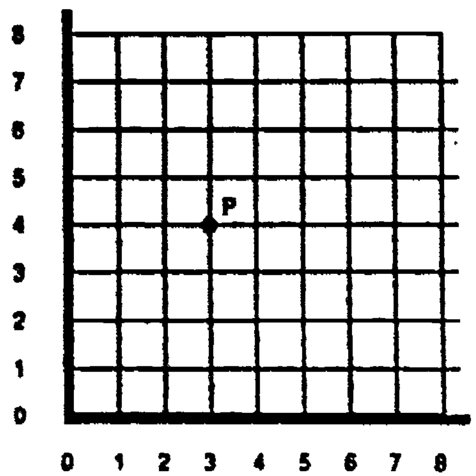
42 B) Q and R

8 C) P and R

19 D) All the points are the same distance apart.

12 E) I don't know.

3.7 B 30. What are the coordinates of point P?



35 A) (3, 4)

41 B) (4, 3)

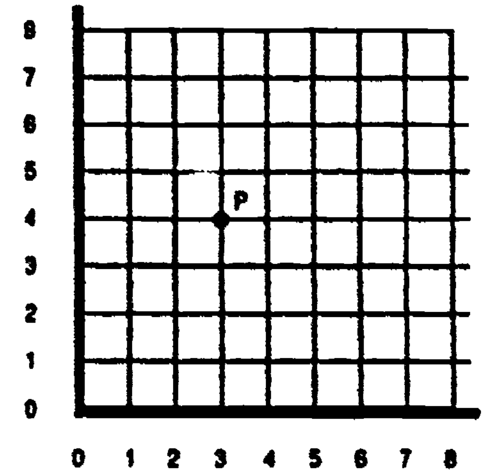
5 C) (5, 4)

5 D) (4, 5)

13 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
38 A) 0 - 20%	3 A) It was done in a previous school year
17 B) 21 - 40%	33 B) It was done during this school year
19 C) 41 - 60%	36 C) It will be done later this year
16 D) 61 - 80%	22 D) It will be done in a subsequent year.
10 E) 81 - 100%	6 E) It will not be done for reasons not listed here

3.7 D 33. What are the coordinates of point P?



2 A) (15, 20)

71 B) (3, 4)

3 C) (20, 15)

6 D) (4, 5)

17 E) I don't know.

4.3 A 38. What unit should be used to measure the length of a fence around a vegetable garden?

7 A) millimetres

7 B) centimetres

69 C) metres

8 D) kilometres

3 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
5 A) 0 - 20%	6 A) It was done in a previous school year
9 B) 21 - 40%	81 B) It was done during this school year
21 C) 41 - 60%	12 C) It will be done later this year
37 D) 61 80%	3 D) It will be done in a subsequent year
28 E) 81 100%	0 E) It will not be done for reasons not listed here

4.1 B 36. How many centimetres are in one metre?

3 A) 1

9 B) 10

56 C) 100

15 D) 1000

4 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.			Indicate whether you taught or reviewed the mathematics needed to answer this item correctly? Mark only one.		
5	A)	0 - 20%	38	A)	It was done in a previous school year
8	B)	21 - 40%	46	B)	It was done during this school year.
17	C)	41 - 60%	11	C)	It will be done later this year.
31	D)	61 - 80%	2	D)	It will be done in a subsequent year.
39	E)	81 - 100%	3	E)	It will not be done for reasons not listed here

4.1 C 39. Bella can jump 627 cm high. Dana can jump 5 m high. How much higher can Bella jump than Dana?

32 A) 127 cm

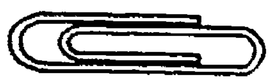
20 B) 622 cm

16 C) 22 cm

8 D) 632 cm

13 E) I don't know.

4.1 D 38. About how long is this jumbo paper clip?



27 A) 5 mm

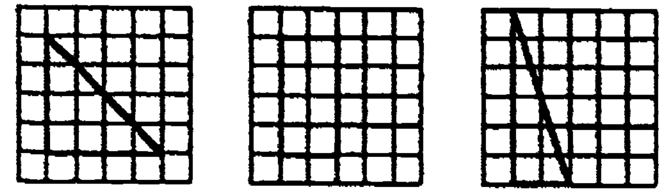
48 B) 50 mm

8 C) 100 mm

6 D) 150 mm

4 E) I don't know.

4.2 A 39. Which two figures have the same area?



35 A) P and Q have the same area.

12 B) Q and R have the same area.

21 C) P and R have the same area.

17 D) Each shape has a different area.

8 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance			Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.		
28	A)	0 - 20%	2	A)	It was done in a previous school year.
22	B)	21 - 40%	52	B)	It was done during this school year.
25	C)	41 - 60%	25	C)	It will be done later this year.
21	D)	61 - 80%	17	D)	It will be done in a subsequent year.
5	E)	81 - 100%	4	E)	It will not be done for reasons not listed here

4.2 B 3?. The area of this postage stamp is about

39 A) 6 cm^2

34 B) 6 cm

6 C) 60 cm

6 D) 60 cm^2

10 E) I don't know.

4.2 C 35. What is the correct way to write "6 square metres"?

39 A) 6 m^2

33 B) 6 sq. mtrs.

8 C) 6 m^3

9 D) 6 m.s.

7 E) I don't know

Estimate what percentage of the students in your class will get this item correct other than by chance			Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.		
26	A)	0 - 20%	3	A)	It was done in a previous school year
16	B)	21 - 40%	57	B)	It was done during this school year.
14	C)	41 - 60%	19	C)	It will be done later this year.
26	D)	61 - 80%	18	D)	It will be done in a subsequent year.
17	E)	81 - 100%	4	E)	It will not be done for reasons not listed here

4.2 D 39. What is the area of this shape in square centimetres?

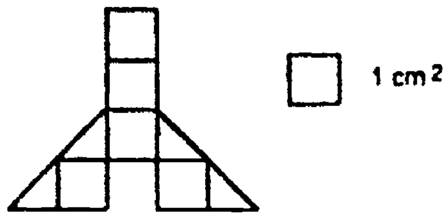
38 A) 7 cm²

8 B) 12 cm²

14 C) 9 cm²

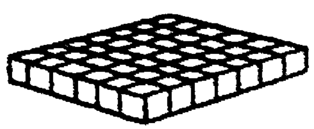
18 D) 5 cm²

14 E) I don't know.



	Estimate what percentage of the students in your class will get this item correct other than by chance		Indicate whether you taught or reviewed the mathematics needed to answer this item correctly? Mark only one.
27	A) 0 - 20%	3	A) It was done in a previous school year
18	B) 21 - 40%	53	B) It was done during this school year
11	C) 41 - 60%	22	C) It will be done later this year.
21	D) 61 - 80%	20	D) It will be done in a subsequent year.
13	E) 81 - 100%	3	E) It will not be done for reasons not listed here

4.3 D 35. What is the volume of the figure?



53 A) 42 cubic units

5 B) 13 cubic units

5 C) 25 cubic units

14 D) 55 cubic units

11 E) I don't know.

	Estimate what percentage of the students in your class will get this item correct other than by chance		Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
27	A) 0 - 20%	3	A) It was done in a previous school year
17	B) 21 - 40%	55	B) It was done during this school year
18	C) 41 - 60%	26	C) It will be done later this year
24	D) 61 - 80%	13	D) It will be done in a subsequent year
15	E) 81 - 100%	3	E) It will not be done for reasons not listed here

4.4 A 36 What unit should be used to measure the capacity of a pop can?

49 A) mL

11 B) g

7 C) mm

21 D) cm

7 E) I don't know.

	Estimate what percentage of the students in your class will get this item correct other than by chance		Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
13	A) 0 - 20%	6	A) It was done in a previous school year.
17	B) 21 - 40%	65	B) It was done during this school year.
25	C) 41 - 60%	21	C) It will be done later this year.
27	D) 61 - 80%	3	D) It will be done in a subsequent year.
18	E) 81 - 100%	2	E) It will not be done for reasons not listed here

4.4 B 39 Each can of pop holds 340 mL. How many millilitres of pop are there in a six-pack?

19 A) 3400 mL

7 B) 346 mL

51 C) 2040 mL

13 D) 1840 mL

10 E) I don't know.

4.5 A 40 A plate with 6 cookies on it weighs 312 g. The plate weighs 72 g. About how much does one cookie weigh?

5 A) 410 g

17 B) 240 g

29 C) 40 g

38 D) 12 g

10 E) I don't know.

4.5 C 38 A ten-year-old boy is likely to weigh

5 A) 35 g

14 B) 75 g

22 C) 35 kg

47 D) 75 kg

6 E) I don't know.

4.5 D 37. What unit should you use when you weigh an apple?

3 A) millimetres

9 B) centimetres

5 C) millilitres

80 D) grams

4 E) I don't know.

4.6 C 40. Sandy and Lee played a game from 4:25 to 5:00. How many minutes did they play?

9 A) 25

58 B) 35

26 C) 75

3 D) 15

3 E) I don't know

4.7 A 37. The temperature on a sunny summer day would most likely be

9 A) 5° Celsius.

48 B) 25° Celsius.

20 C) 55° Celsius.

16 D) 85° Celsius.

6 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance			Indicate whether you taught or reviewed the mathematics needed to answer this item correctly? Mark only one.		
18	A)	0 - 20%	18	A)	It was done in a previous school year
13	B)	21 - 40%	30	B)	It was done during this school year
2?	C)	41 - 60%	19	C)	It will be done later this year.
29	D)	61 - 80%	7	D)	It will be done in a subsequent year
13	E)	81 - 100%	6	E)	It will not be done for reasons not listed here

4.8 B 38. Darlene has 6 coins in her pocket. The coins have a total value of 75¢. Which of the following lists tells what coins Darlene has in her pocket?

43 A) 2 quarters, 1 dime, and 3 nickels

6 B) 1 quarter, 4 dimes, and 1 nickel

8 C) 2 quarters, 2 dimes, and 2 nickels

29 D) 2 quarters, 2 dimes, and 5 pennies

8 E) I don't know.

NS B 40 About how much does a horse weigh?

2 A) 4 kg

8 B) 40 kg

56 C) 400 kg

30 D) 4000 kg

8 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.			Indicate whether you taught or reviewed the mathematics needed to answer this item correctly? Mark only one.		
20	A)	0 - 20%	5	A)	It was done in a previous school year
25	B)	21 - 40%	55	B)	It was done during this school year
32	C)	41 - 60%	21	C)	It will be done later this year.
19	D)	61 - 80%	12	D)	It will be done in a subsequent year
4	F)	81 - 100%	7	E)	It will not be done for reasons not listed here

NS C 19. If you divide any number except 0 by a number greater than 2, then the answer will be

21 A) less than half of the original number.

24 B) more than half of the original number.

17 C) a fraction.

16 D) 'mpossible to predict.

21 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.			Indicate whether you taught or reviewed the mathematics needed to answer this item correctly? Mark only one.		
57	A)	0 - 20%	1	A)	It was done in a previous school year.
23	B)	21 - 40%	33	B)	It was done during this school year.
13	C)	41 - 60%	13	C)	It will be done later this year.
5	D)	61 - 80%	34	D)	It will be done in a subsequent year.
1	E)	81 - 100%	30	E)	It will not be done for reasons not listed here

NS D 19. How high would a stack of one million pennies be?

32 A) 2 m

22 B) 200 m

18 C) 2 000 m

13 D) 20 000 m

14 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance			Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.		
51	A)	0 - 20%	7	A)	It was done in a previous school year
24	B)	21 - 40%	28	B)	It was done during this school year
18	C)	41 - 60%	16	C)	It will be done later this year.
6	D)	61 - 80%	22	D)	It will be done in a subsequent year
2	E)	81 - 100%	33	E)	It will not be done for reasons not listed here

APPENDIX F

Grade 7 Student Achievement Items

GRADE 7 STUDENT ACHIEVEMENT SURVEY

1.1 A 2. As of June 1, 1976, the population of Canada was 22 589 416. Round off 22 589 416 to the nearest ten thousand.

- 5 A) 22 580 000
- 8 B) 23 000 000
- 10 C) 22 600 000
- 75 D) 22 590 000
- 2 E) I don't know.

1.1 B 2. Which one of the following is equal to 700 070?

- 4 A) seven hundred seventy
- 7 B) seven thousand seventy
- 84 C) seven hundred thousand seventy
- 4 D) seven million seventy
- 1 E) I don't know.

1.1 B 4. Write $(8 \times 10^6) + (7 \times 10^3) + (6 \times 10^1)$ in standard form.

- 13 A) 8 000 706
- 13 B) 8 000 760
- 49 C) 8 007 060
- 13 D) 8 070 060
- 10 E) I don't know.

1.1 C 1. Which one of the following is equal to seven hundred million eighty-nine thousand four?

- 5 A) 70 089 004
- 3 B) 70 890 004
- 74 C) 700 089 004
- 17 D) 700 890 004
- 1 E) I don't know.

1.1 D 2. What is the place value of the 6 in 12.345 67?

- 11 A) tenths
- 2 B) hundredths
- 6 C) thousandths
- 80 D) ten-thousandths
- 1 E) I don't know.

1.2 A 1. Subtract: 2008
− 189

- 7 A) 819
- 2 B) 1181
- 88 C) 1819
- 2 D) 2181
- 1 E) I don't know.

1.2 A 3. Meg wants to mail party invitations to 36 friends. Envelopes are only sold in packets of 15 and cost 75¢ per packet. How much will she have to spend for envelopes?

- 7 A) $1.50
- 11 B) $1.80
- 74 C) $2.25
- 4 D) $2.70
- 3 E) I don't know.

1.2 A 5. Estimate the product: 9.785 x 11.134 x 2.9065 x 8.910

- 51 A) 3000
- 23 B) 2000
- 8 C) 300
- 5 D) 200
- 13 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
9 A) 0 - 20%	4 A) It was done in a previous school year
19 B) 21 - 40%	90 B) It was done during this school year
31 C) 41 - 60%	3 C) It will be done later this year
35 D) 61 - 80%	1 D) It will be done in a subsequent year
7 E) 81 - 100%	3 E) It will not be done for reasons not listed here

1.2 B 1. Divide: $45\overline{)1232}$

9 A) 25 remainder 7

22 B) 27 remainder 17

7 C) 29 remainder 27

4 D) 207 remainder 17

6 E) I don't know.

1.2 C 5. Ms. Brown borrowed $3500 from the bank. She agreed to repay the loan in 36 monthly payments of $180. How much money in total was repaid?

3 A) $ 216

10 B) $3680

5 C) $3716

75 D) $6480

7 E) I don't know.

1.2 D 1. Multiply:

$$\begin{array}{r} 403 \\ \underline{\times 59} \end{array}$$

5 A) 24 337

3 B) 5842

84 C) 23 777

5 D) 3827

3 E) I don't know.

1.3 A 4. The value of 3 + 4(5 + 2) is

8 A) 25

5 B) 26

12 C) 31

49 D) 49

25 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
9 A) 0 - 20%	1 A) It was done in a previous school year
11 B) 21 - 40%	86 B) It was done during this school year
23 C) 41 - 60%	10 C) It will be done later this year.
38 D) 61 - 80%	2 D) It will be done in a subsequent year
19 E) 81 - 100%	1 E) It will not be done for reasons not listed here

1.3 B 3. Simplify: 64 - [5 + 6 x (9 - 5)]

3 A) 10

42 B) 20

41 C) 35

5 D) 108

8 E) I don't know.

1.3 C 4. The greatest common factor of 24 and 30 is

5 A) 2

74 B) 6

15 C) 120

3 D) 60

3 E) I don't know.

1.3 C 6. Which of the following numbers is the product of two identical prime factors?

46 A) 4

17 B) 6

11 C) 15

12 D) 36

13 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
10 A) 0 - 20%	5 A) It was done in a previous school year
19 B) 21 - 40%	87 B) It was done during this school year
29 C) 41 - 60%	5 C) It will be done later this year
17 D) 61 - 80%	1 D) It will be done in a subsequent year
11 E) 81 - 100%	2 E) It will not be done for reasons not listed here

1.3 D 3. It takes Wendy 6 minutes to run around the fitness track. It takes Pat 8 minutes to run around the track. They both start running around the track at the same time and continue to run until they reach the start at the same time. In how many minutes will they first meet again at the start?

23 A) 2

9 B) 12

46 C) 24

16 D) 48

6 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
21 A) 0 - 20%	6 A) It was done in a previous school year
26 B) 21 - 40%	79 B) It was done during this school year
32 C) 41 - 60%	9 C) It will be done later this year
18 D) 61 - 80%	3 D) It will be done in a subsequent year.
4 E) 81 - 100%	4 E) It will not be done for reasons not listed here

1.3 D 4. The number of bacteria in a jar doubles every hour. If there are 15 bacteria in the jar at noon, how many will be in the jar six hours later?

13 A) 15^6

43 B) 90

10 C) 180

30 D) 960

4 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
12 A) 0 - 20%	4 A) It was done in a previous school year
24 B) 21 - 40%	80 B) It was done during this school year
31 C) 41 - 60%	7 C) It will be done later this year.
25 D) 61 - 80%	3 D) It will be done in a subsequent year
8 E) 81 - 100%	5 E) It will not be done for reasons not listed here

2.1 A 7. Which one of the following numbers is largest?

13 A) 0.694

5 B) 0.07

65 C) 0.76

16 D) 0.0816

1 E) I don't know.

2.1 A 8 Dividing by 1000 is the same as multiplying by which one of the following?

8 A) 0.01

61 B) 0.001

22 C) 0.000 1

2 D) 0.000 01

6 E) I don't know.

Estimate what percentage of the students in your clas , will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
8 A) 0 - 20%	4 A) It was done in a previous school year
20 B) 21 - 40%	91 B) It was done during this school year.
34 C) 41 - 60%	3 C) It will be done later this year.
30 D) 61 - 80%	1 D) It will be done in a subsequent year.
8 E) 81 - 100%	2 E) It will not be done for reasons not listed here

2.1 B 6 Divide $12\overline{)036}$

16 A) 3

14 B) 0.003

52 C) 0.3

14 D) 0.03

3 E) I don't know

2.1 B 7 Multiply: 0.01 x 2300

55 A) 23

5 B) 230

26 C) 2 300

10 D) 23 000

3 E) I don't know

2.1 B 10 There are 25 students in Mary's class. The class goes on a field trip to the museum. If tickets cost $2.85 each, what is the total cost of tickets for the class?

1 A) $8.77

3 B) $19.95

91 C) $71.25

3 D) $91.20

2 E) I don't know

2.1 B 11. A stack of 40 sheets of construction paper is 2.5 cm thick. What is the thickness of one sheet of paper?

14 A) 0.01 cm

14 B) 0.016 cm

33 C) 0.0625 cm

28 D) 0.16 cm

11 E) I don't know.

2.1 C 2. Subtract: 51.2 − 4.35

15 A) 48.95

69 B) 46.85

3 C) 17.7

9 D) 7.7

4 E) I don't know.

2.1 C 8. How many shakes can I buy with $4.20?

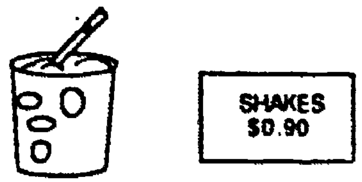
1 A) 2

5 B) 3

81 C) 4

11 D) 5

2 E) I don't know.



2.1 C 9. One litre of skim milk contains 0.36 mg of thiamin. How much thiamin is in a 0.25 L serving of skim milk?

4 A) 0.0252 mg

57 B) 0.09 mg

9 C) 0.894 mg

12 D) 1.44 mg

18 E) I don't know.

2.1 C 10. Which of the following products is 4 000 008 000 004?

11 A) 2 000 02 x 2 000 02

38 B) 2 000 002 x 2 000 002

15 C) 2 000 000 2 x 2 000 000 2

17 D) 2 000 000 02 x 2 000 000 02

19 E) I don't know.

2.1 D 6. 3 008 written in words is

2 A) three hundred eight.

9 B) three thousand eight.

8 C) three and eight hundredths.

80 D) three and eight thousandths.

1 E) I don't know.

2.1 D 7. Write 0.375 as a fraction in lowest terms.

24 A) $\frac{375}{1000}$

9 B) $\frac{75}{200}$

46 C) $\frac{3}{8}$

13 D) $\frac{5}{8}$

8 E) I don't know.

2.2 A 8. Write $\frac{8}{12}$ in lowest terms.

6 A) $\frac{3}{4}$

87 B) $\frac{2}{3}$

2 C) $1\frac{1}{2}$

3 D) $1\frac{1}{3}$

2 E) I don't know.

2.2 A 9. John had 12 baseball cards. He gave $\frac{1}{3}$ of them to Jim. How many does John have left?

29 A) 4

4 B) 8

49 C) 8

16 D) 9

2 E) I don't know.

2.2 A 10. Each of the students in the drama club ate $\frac{2}{3}$ of a pizza at the year-end party. If they ate 12 pizzas in total, how many students are there in the club?

25 A) 8

32 B) 18

18 C) 24

12 D) 36

8 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
19 A) 0 - 20%	3 A) It was done in a previous school year
23 B) 21 - 40%	83 B) It was done during this school year
29 C) 41 - 60%	10 C) It will be done later this year.
29 D) 61 - 80%	3 D) It will be done in a subsequent year
8 E) 81 - 100%	1 E) It will not be done for reasons not listed here

2.2 B 8 Written as a decimal, $\frac{1}{8}$ =

5 A) 0.12

38 B) 0.8

42 C) 0.125

9 D) 0.18

5 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
5 A) 0 - 20%	2 A) It was done in a previous school year
13 B) 21 - 40%	87 B) It was done during this school year
23 C) 41 - 60%	10 C) It will be done later this year
39 D) 61 - 80%	1 D) It will be done in a subsequent year
18 E) 81 - 100%	0 E) It will not be done for reasons not listed here

2.2 C 3. Add. $\frac{1}{2} + \frac{1}{3}$

34 A) $\frac{2}{5}$

8 B) $\frac{1}{5}$

5 C) $\frac{1}{6}$

51 D) $\frac{5}{6}$

2 E) I don't know

2.2 D 8 Subtract $7 - \frac{5}{6}$

11 A) $7\frac{1}{6}$

6 B) $7\frac{5}{6}$

21 C) $\frac{2}{6}$

52 D) $6\frac{1}{6}$

10 E) I don't know

2.2 D 9 Subtract $8\frac{5}{8} - 3\frac{3}{8}$

3 A) $\frac{1}{4}$

6 B) 5

8 C) $5\frac{1}{16}$

73 D) $5\frac{1}{4}$

9 E) I don't know.

2.2 D 10. Which number is largest?

22 A) $\frac{2}{3}$

39 B) $\frac{4}{5}$

13 C) $\frac{3}{4}$

21 D) $\frac{5}{8}$

5 E) I don't know

2.2 D 11 Mrs. Smith baked 48 cookies. Billy ate $\frac{3}{8}$ of the cookies and Betty ate $\frac{1}{8}$ of the cookies. In all, how many cookies were eaten?

13 A) 16

9 B) 18

9 C) 20

62 D) 24

7 E) I don't know

2.2 D 12. The skating club wants to sell 120 tickets to their fund raising supper. They have sold $\frac{5}{6}$ of the tickets. How many are left to sell?

- 8 A) 10
- 51 B) 20
- 15 C) 83
- 18 D) 100
- 7 E) I don't know.

2.2 C 15. Jan gave half of her marbles to James and then a third of what was left to Pat. Jan was left with 6 marbles. How many did she have to start with?

- 50 A) 18
- 16 B) 24
- 6 C) 30
- 23 D) 36
- 4 E) I don't know.

2.3 A 11. Which one of the following is equivalent to 2 : 3 ?

- 3 A) 3 : 4
- 3 B) 5 : 12
- 15 C) 3 : 2
- 77 D) 4 : 6
- 4 E) I don't know.

2.3 A 12. A machine seals 225 boxes in 3 hours. There are 1000 boxes to seal. How many will be left unsealed after an 8-hour shift?

- 50 A) 400
- 23 B) 600
- 9 C) 800
- 6 D) 925
- 11 E) I don't know

2.3 A 13. There are 140 players in a tournament. The ratio of girls to boys is 3 : 4. How many girls are there?

- 14 A) 40
- 36 B) 60
- 16 C) 80
- 22 D) 105
- 12 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
15 A) 0 - 20%	2 A) It was done in a previous school year
20 B) 21 - 40%	68 B) It was done during this school year
33 C) 41 - 60%	26 C) It will be done later this year.
24 D) 61 - 80%	2 D) It will be done in a subsequent year
8 E) 81 - 100%	2 E) It will not be done for reasons not listed here

2.3 A 14. Write 45% as a fraction in lowest terms.

- 22 A) $\frac{1}{45}$
- 8 B) $\frac{4}{5}$
- 10 C) $\frac{1}{5}$
- 52 D) $\frac{9}{20}$
- 7 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
11 A) 0 - 20%	2 A) It was done in a previous school year
11 B) 21 - 40%	75 B) It was done during this school year
25 C) 41 - 60%	20 C) It will be done later this year.
33 D) 61 - 80%	3 D) It will be done in a subsequent year
21 E) 81 - 100%	2 E) It will not be done for reasons not listed here

2.3 A 15. Which one of the following shows a discount of 10%?

- 75 A) 30¢ off $3.00
- 4 B) 35¢ off $3.00
- 9 C) 40¢ off $3.00
- 4 D) 45¢ off $3.00
- 8 E) I don't know

2.3 B 12. A map of B.C. is to be drawn so that 1 mm represents 5 km. If the actual distance between Vernon and Penticton is 125 km, how many millimetres apart should these two points be on the map?

5 A) 125

9 B) 625

4 C) 120

78 D) 25

4 E) I don't know.

2.3 B 13. If 4 volleyballs cost \$96.00, how much will 10 volleyballs cost?

27 A) \$960.00

63 B) \$240.00

2 C) \$24.00

5 D) \$384.00

2 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
2 A) 0 - 20%	6 A) It was done in a previous school year
10 B) 21 - 40%	89 B) It was done during this school year
22 C) 41 - 60%	4 C) It will be done later this year
36 D) 61 - 80%	0 D) It will be done in a subsequent year
30 E) 81 - 100%	1 E) It will not be done for reasons not listed here

2.3 B 14. Forty percent of the students in the class wear glasses. If 10 students wear glasses, how many students are in the class?

6 A) 4

18 B) 24

46 C) 25

20 D) 40

9 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
13 A) 0 - 20%	4 A) It was done in a previous school year
20 B) 21 - 40%	65 B) It was done during this school year
33 C) 41 - 60%	24 C) It will be done later this year
24 D) 61 - 80%	3 D) It will be done in a subsequent year
10 E) 81 - 100%	3 E) It will not be done for reasons not listed here

2.3 B 15. The number *a* is larger than the number *b*. Therefore

6 A) *a* is less than 1% of *b*.

6 B) *a* is less than 100% of *b*.

7 C) *a* is exactly 100% of *b*.

64 D) *a* is more than 100% of *b*.

17 E) I don't know.

2.3 C 12. Written as a percent, $\frac{1}{5}$ =

23 A) 5%

15 B) 0.5%

55 C) 20%

4 D) 50%

2 E) I don't know.

2.3 C 13. What is 24% of \$150.00?

8 A) $\frac{24}{100}$

11 B) \$24.00

62 C) \$36.00

5 D) \$174.00

14 E) I don't know.

2.3 C 14. What percent of 20 is 13?

15 A) 26%

10 B) 39%

11 C) 52%

50 D) 65%

15 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
18 A) 0 - 20%	1 A) It was done in a previous school year
15 B) 21 - 40%	63 B) It was done during this school year
28 C) 41 - 60%	33 C) It will be done later this year.
27 D) 61 - 80%	2 D) It will be done in a subsequent year
12 E) 81 - 100%	2 E) It will not be done for reasons not listed here

2.3 D 14. What is 90% written as a decimal fraction?

11 A) 0.09

60 B) 0.9

6 C) 9.0

20 D) 90.0

3 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
4 A) 0 - 20%	5 A) It was done in a previous school year
10 B) 21 - 40%	80 B) It was done during this school year
16 C) 41 - 60%	14 C) It will be done later this year.
34 D) 61 - 80%	1 D) It will be done in a subsequent year
36 E) 81 - 100%	1 E) It will not be done for reasons not listed here

2.3 D 15. Which rate is equivalent to the ratio of 120 km : 3 h ?

2 A) 25 km/h

4 B) 36 km/h

67 C) 40 km/h

16 D) 360 km/h

11 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
11 A) 0 - 20%	4 A) It was done in a previous school year
13 B) 21 - 40%	74 B) It was done during this school year.
25 C) 41 - 60%	20 C) It will be done later this year.
35 D) 61 - 80%	1 D) It will be done in a subsequent year
15 E) 81 - 100%	1 E) It will not be done for reasons not listed here

2.4 A 16. What is the opposite of −2?

5 A) $\frac{-1}{2}$

3 B) $\frac{1}{2}$

6 C) 0

80 D) 2

6 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
31 A) 0 - 20%	3 A) It was done in a previous school year
12 B) 21 - 40%	40 B) It was done during this school year
14 C) 41 - 60%	41 C) It will be done later this year.
18 D) 61 - 80%	12 D) It will be done in a subsequent year
25 E) 81 - 100%	4 E) It will not be done for reasons not listed here

2.4 A 17. When a positive number is divided by a negative number, the answer is

16 A) positive

22 B) negative

10 C) zero

38 D) You can't tell without knowing what the numbers are.

8 E) I don't know

2.4 A 15. Which of the following statements is false?

7 A) Zero is smaller than any positive number.

7 B) All positive numbers are larger than zero.

19 C) All positive numbers are larger than all negative numbers.

58 D) Zero is smaller than any negative number.

9 E) I don't know.

2.4 B 16. On one day in the early spring the temperature in Prince George was − 6°C, in Vernon it was − 4°C, in Kamloops it was − 3°C, and in Castlegar it was − 9°C. Which city was warmest that day?

2 A) Prince George

2 B) Vernon

63 C) Kamloops

32 D) Castlegar

1 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
4 A) 0 - 20%	18 A) It was done in a previous school year
6 B) 21 - 40%	57 B) It was done during this school year.
13 C) 41 - 60%	19 C) It will be done later this year.
26 D) 61 - 80%	3 D) It will be done in a subsequent year
51 E) 81 - 100%	3 E) It will not be done for reasons not listed here

2.4 B 17. Multiply: $(-2)(-3)$

51 A) − 6

13 B) − 5

5 C) 5

23 D) 6

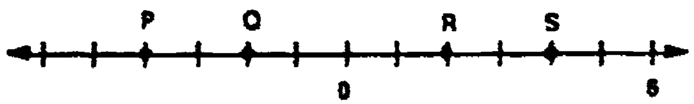
7 E) I don't know

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
50 A) 0 - 20%	1 A) It was done in a previous school year
15 B) 21 - 40%	29 B) It was done during this school year
12 C) 41 - 60%	14 C) It will be done later this year
13 D) 61 - 80%	18 D) It will be done in a subsequent year
10 E) 81 - 100%	6 E) It will not be done for reasons not listed here

2.4 B 15. The temperature went from 5°C to − 7°C over a period of 2 days. What was the average temperature change per day?

43 A) − 6 degrees
16 B) − 1 degree
17 C) 1 degree
15 D) 12 degrees
6 E) I don't know.

2.4 C 16. The integer − 4 is at which point on the number line below?



58 A) P
9 B) Q
6 C) R
21 D) S
7 E) I don't know.

	Estimate what percentage of the students in your class will get this item correct other than by chance.			Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.	
17	A)	0 - 20%	6	A)	It was done in a previous school year
16	B)	21 - 40%	47	B)	It was done during this school year
17	C)	41 - 60%	39	C)	It will be done later this year.
22	D)	61 - 80%	5	D)	It will be done in a subsequent year.
29	E)	81 - 100%	3	E)	It will not be done for reasons not listed here

2.4 C 17. Add: (− 6) + 4

17 A) − 10
62 B) − 2
7 C) 2
6 D) 10
4 E) I don't know.

	Estimate what percentage of the students in your class will get this item correct other than by chance			Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.	
26	A)	0 - 20%	4	A)	It was done in a previous school year
19	B)	21 - 40%	40	B)	It was done during this school year.
19	C)	41 - 60%	45	C)	It will be done later this year.
19	D)	61 - 80%	9	D)	It will be done in a subsequent year
19	E)	81 - 100%	4	E)	It will not be done for reasons not listed here

2.4 C 18 Divide: (− 36) ÷ (− 4)

60 A) − 9
4 B) − 6
3 C) 6
23 D) 9
9 E) I don't know.

	Estimate what percentage of the students in your class will get this item correct other than by chance.			Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.	
37	A)	0 - 20%	3	A)	It was done in a previous school year
15	B)	21 - 40%	24	B)	It was done during this school year.
10	C)	41 - 60%	44	C)	It will be done later this year.
12	D)	61 - 80%	25	D)	It will be done in a subsequent year
7	E)	81 - 100%	4	E)	It will not be done for reasons not listed here

2.4 D 16. Which one of the following would you likely not use negative integers to describe?

14 A) The depth of the ocean floor
9 B) A bank balance
55 C) A person's age
7 D) A temperature
14 E) I don't know.

	Estimate what percentage of the students in your class will get this item correct other than by chance			Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.	
31	A)	0 - 20%	3	A)	It was done in a previous school year
17	B)	21 - 40%	40	B)	It was done during this school year.
20	C)	41 - 60%	41	C)	It will be done later this year.
17	D)	61 - 80%	11	D)	It will be done in a subsequent year
15	E)	81 - 100%	5	E)	It will not be done for reasons not listed here

2.4 D 17 The temperature at Kamloops is − 6°C. The temperature in Victoria is 4°C. What is the difference in temperature between Victoria and Kamloops?

40 A) 2 degrees
2 B) 4 degrees
3 C) 6 degrees
53 D) 10 degrees
2 E) I don't know

2.4 D 18. Suppose the temperature at base camp was 0°C at noon. The temperature rose 2 degrees per hour until 17:00, and then declined 3 degrees per hour until midnight. What was the temperature at base camp at midnight?

18 A) −1°C

34 B) − 10°C

43 C) − 11°C

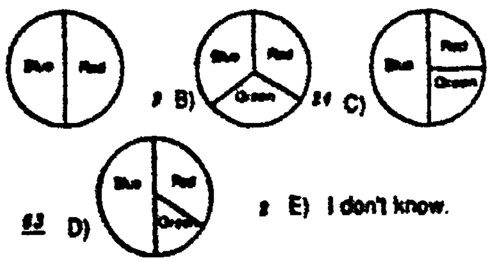
15 D) − 21°C

9 E) I don't know.

3.1 A 22. What spinner would you use to conduct a probability experiment on your friends' favourite colours if half of them prefer blue, a third of them prefer red, and the rest like green?

2 A) 9 B) 24 C)

63 D) 2 E) I don't know.



Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
33 A) 0 - 20%	7 A) It was done in a previous school year
22 B) 21 - 40%	28 B) It was done during this school year
22 C) 41 - 60%	27 C) It will be done later this year.
19 D) 61 - 80%	24 D) It will be done in a subsequent year.
9 E) 81 - 100%	14 E) It will not be done for reasons not listed here

3.1 A 24. To find out how much time Grade 7 students spend watching TV, whom should you ask?

3 A) Your friends

28 B) The parents of Grade 7 students

64 C) Grade 7 students

4 D) Students in the school

1 E) I don't know.

3.1 C 22. You are designing a questionnaire to determine the kinds of pets that Grade 7 students have at home. Which set of questions is most appropriate to ask children outside a movie theatre?

62 A) What grade are you in? What pets do you have?

11 B) Do you have a dog? Do you have a cat?

15 C) How old are you? What animals do you like best?

5 D) What pets do you own? Are you a boy or a girl?

2 E) I don't know

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
8 A) 0 - 20%	13 A) It was done in a previous school year
13 B) 21 - 40%	45 B) It was done during this school year.
25 C) 41 - 60%	19 C) It will be done later this year.
34 D) 61 - 80%	8 D) It will be done in a subsequent year
19 E) 81 - 100%	13 E) It will not be done for reasons not listed here

3.1 D 20 If 5 children in your classroom were chosen at random, they would be a representative sample of all the children

15 A) in your school.

73 B) in your class.

3 C) in your city.

3 D) in Canada.

5 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
25 A) 0 - 20%	12 A) It was done in a previous school year
19 B) 21 - 40%	28 B) It was done during this school year
28 C) 41 - 60%	34 C) It will be done later this year.
16 D) 61 - 80%	13 D) It will be done in a subsequent year
12 E) 81 - 100%	13 E) It will not be done for reasons not listed here

3.1 D 21. Sondra wanted to find out how people in her town felt about the new community centre. She collected data by asking the opinions of the people in her mathematics class. Do you think that this was a good way to do it?

10 A) Yes, because boys and girls were both asked

63 B) No, because Sondra only got opinions from teenagers and not adults.

14 C) Yes, because her class has people who are from all walks of life

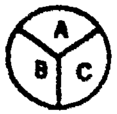
7 D) No, because teenagers are not well-enough informed.

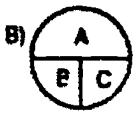
5 E) I don't know

3.2 C 23. Sparky Spencer spun a spinner 100 times and made a record of his results.

Outcome	A	B	C
Number of times	55	30	15

Which spinner did he most likely use?

18 A) 

8 B) 

14 C) 

58 D) 

7 E) I don't know

3 2 D 23. Here is a stem-and-leaf plot of scores on a mathematics test. Which list of scores matches the stem-and-leaf plot?

5	3
6	1 5 7
7	2 4 8
8	2 4 8
9	1

6 A) 1, 1, 2, 3, 3, 5, 5, 7, 8

12 B) 1, 1, 2, 3, 3, 4, 5, 5, 5, 6, 7, 7, 8, 8, 9

14 C) 53, 61, 57, 72, 48, 83, 85, 91

26 D) 53, 61, 65, 67, 72, 74, 78, 82, 84, 88, 91

41 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
77 A) 0 - 20%	3 A) It was done in a previous school year
10 B) 21 - 40%	11 B) It was done during this school year
6 C) 41 - 60%	25 C) It will be done later this year
4 D) 61 - 80%	29 D) It will be done in a subsequent year
3 E) 81 - 100%	35 E) It will not be done for reasons not listed here

3.3 B 20 The graph below shows what a boy did during a period of 24 hours.

What is the best estimate for the number of hours he spent watching TV?

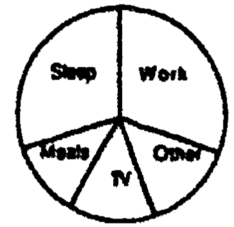
67 A) 3

17 B) 6

6 C) 9

7 D) 12

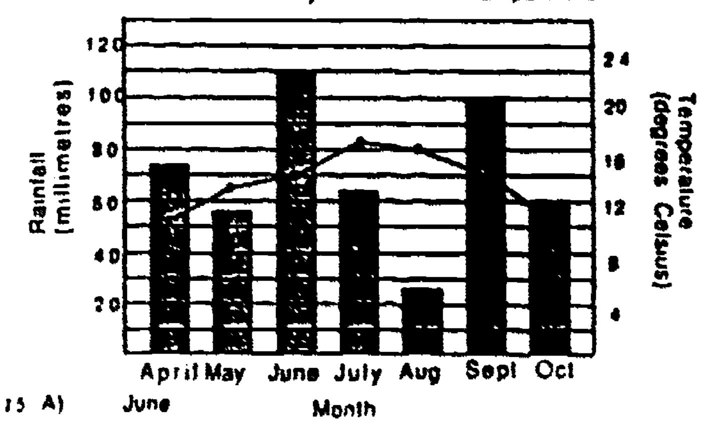
3 E) I don't know



Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
13 A) 0 - 20%	10 A) It was done in a previous school year
20 B) 21 - 40%	51 B) It was done during this school year
32 C) 41 - 60%	26 C) It will be done later this year
27 D) 61 - 80%	7 D) It will be done in a subsequent year
8 E) 81 - 100%	7 E) It will not be done for reasons not listed here

3.3 B 21 Below is a combination bar graph and broken line graph. The bars show monthly rainfall and the broken line shows temperature. Which month appears to have the best weather for hiking and camping outdoors?

Monthly Rainfall and Temperature



15 A) June

14 B) July

66 C) August

3 D) September

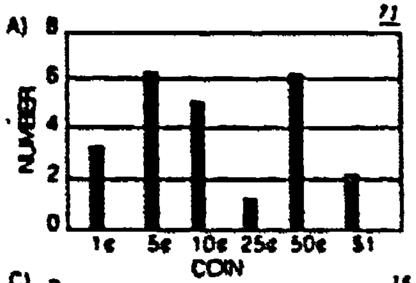
2 E) I don't know.

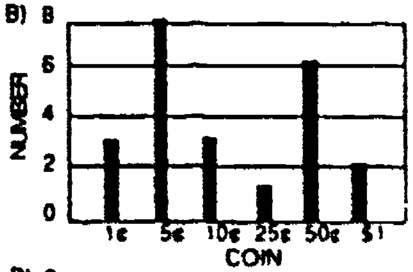
Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
4 A) 0 - 20%	15 A) It was done in a previous school year
9 B) 21 - 40%	57 B) It was done during this school year
28 C) 41 - 60%	22 C) It will be done later this year
39 D) 61 - 80%	3 D) It will be done in a subsequent year
29 E) 81 - 100%	3 E) It will not be done for reasons not listed here

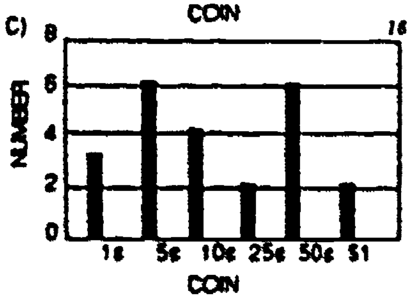
3.2 A 19. The table shows the numbers of various coins found in a box

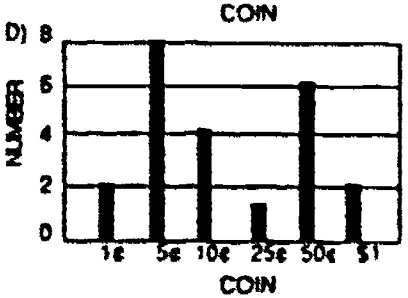
Coin	Number found
$1 (dollar coin)	2
50¢ (fifty-cent piece)	6
25¢ (quarter)	1
10¢ (dime)	3
5¢ (nickel)	8
1¢ (penny)	3

Which one of the following graphs shows this?

3 A)


71 B)


4 C)


16 D)


6 E) I don't know.

3.2 A 23. Two plastic discs are tossed in the air and, when they land, the numbers that show are added together. One of the discs has 1 on one side and 2 on the other. The second disc has 3 on one side and 4 on the other. What sums are possible?

5 A) 5 only

24 B) 1, 2, 3, and 4

42 C) 4, 5, and 6

11 D) 1, 2, 3, 4, 5, and 6

11 E) I don't know

3.2 A 21. For a party game each number shown below was painted on a different ping pong ball, and the balls were thoroughly mixed up in a bowl. If a ball is picked from the bowl by a blindfolded person, what is the probability that the ball will have a 4 on it?

2, 3, 4, 4, 5, 6, 8, 8, 9, 10

7 A) $\frac{1}{2}$

17 B) $\frac{1}{4}$

46 C) $\frac{1}{5}$

23 D) $\frac{1}{10}$

7 E) I don't know

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
19 A) 0 - 20%	9 A) It was done in a previous school year
25 B) 21 - 40%	23 B) It was done during this school year
20 C) 41 - 60%	40 C) It will be done later this year.
13 D) 61 - 80%	19 D) It will be done in a subsequent year.
4 E) 81 - 100%	15 E) It will not be done for reasons not listed here

3.2 C 20 Here is a list of test marks:

3, 4, 5, 4, 5, 5, 5, 3, 3, 1, 4, 5, 0, 4, 5

Which one of the following tables represents this data?

A)

mark	frequency
0	1
1	1
2	0
3	3
4	4
5	6

B)

mark	frequency
0	1
1	2
2	1
3	3
4	3
5	6

C)

mark	frequency
0	1
1	1
2	0
3	3
4	4
5	5

D)

mark	frequency
0	0
1	1
2	2
3	3
4	4
5	5

E) I don't know

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
27 A) 0 - 20%	8 A) It was done in a previous school year
20 B) 21 - 40%	29 B) It was done during this school year
27 C) 41 - 60%	39 C) It will be done later this year.
16 D) 61 - 80%	12 D) It will be done in a subsequent year.
11 E) 81 - 100%	13 E) It will not be done for reasons not listed here

3.3 B 22. The tally chart below shows the finishing times for the first 18 runners in the 5.0 km run. What is the mode of the finishing times?

8 A) 5 minutes

23 B) 20 minutes

9 C) 22 minutes

34 D) 24 minutes

25 E) I don't know.

Time	Tally
17 min	‖
18 min	‖‖
19 min	|
20 min	|
21 min	|
22 min	‖
23 min	‖‖
24 min	‖‖‖

3.3 B 23. A department store has five types of sweaters for sale. The prices of the sweaters are as follows:

$16, $16, $21, $32, $40

What is the mean price of the sweaters?

26 A) $16

15 B) $21

27 C) $25

22 D) $40

9 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
23 A) 0 - 20%	13 A) It was done in a previous school year
22 B) 21 - 40%	43 B) It was done during this school year.
31 C) 41 - 60%	27 C) It will be done later this year.
23 D) 61 - 80%	11 D) It will be done in a subsequent year.
9 E) 81 - 100%	5 E) It will not be done for reasons not listed here

3.3 C 21. The median test mark was 37 out of 50. Billy scored 30 out of 50. Which of the following is true?

32 A) More than half the people who took the test scored higher than Billy.

23 B) Less than half the people who took the test scored higher than Billy.

33 C) Exactly half the people who took the test scored higher than Billy.

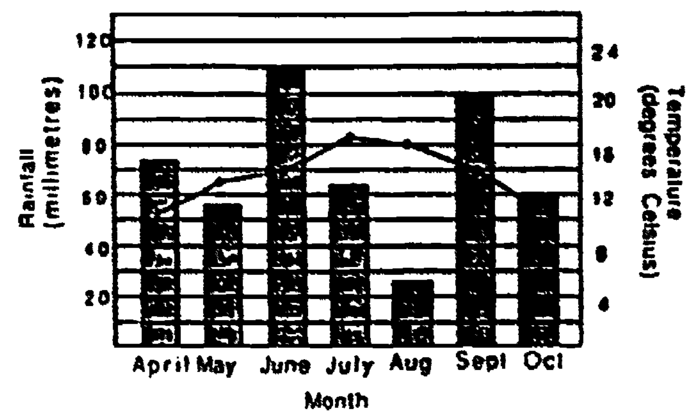
4 D) None of the people who took the test scored higher than Billy.

9 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
27 A) 0 - 20%	10 A) It was done in a previous school year
19 B) 21 - 40%	43 B) It was done during this school year.
20 C) 41 - 60%	29 C) It will be done later this year.
19 D) 61 - 80%	12 D) It will be done in a subsequent year.
5 E) 81 - 100%	8 E) It will not be done for reasons not listed here

3.3 D 22. Below is a combination bar graph and broken line graph. The bars show monthly rainfall and the broken line shows temperature. By how much does April's rainfall exceed October's?

Monthly Rainfall and Temperature



10 A) 1°C

62 B) 13 mm

9 C) 58 mm

11 D) 71 mm

9 E) I don't know.

4.1 A 27. Angle A and Angle B are congruent. If Angle A has a measure of 35°, what is the measure of Angle B?

68 A) 35°

10 B) 55°

8 C) 145°

4 D) 325°

9 E) I don't know.

4.1 A 29. With 4 toothpicks you can make 1 small square. With 7 toothpicks you can make 2 small squares, and with 10 toothpicks you can make 3 small squares. What is the largest number of small squares that you can construct with 34 toothpicks?

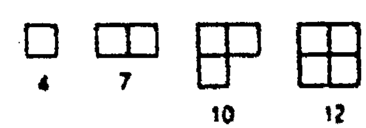
18 A) 10

24 B) 12

28 C) 13

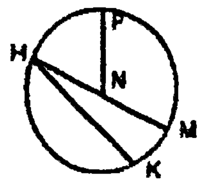
21 D) 16

8 E) I don't know

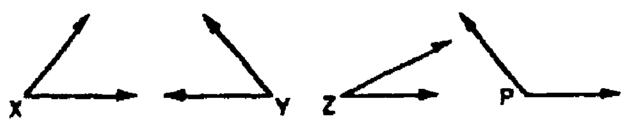


4.1 B 25. If N is the centre, which segment is a diameter?

5 A) HK
20 B) NP
4 C) HP
65 D) HM
6 E) I don't know.



4.1 C 25. Which two angles are congruent?

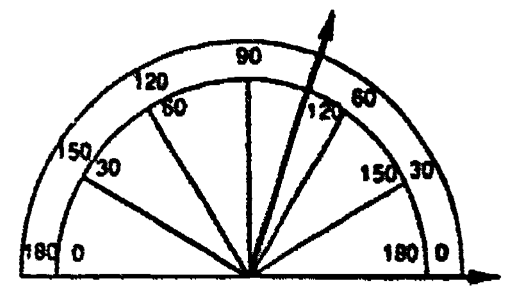


83 A) X and Y
5 B) X and Z
4 C) Y and P
3 D) P and Z
5 E) I don't know

4.1 C 26. Which one of the following triangles has three sides all the same length?

71 A) Equilateral
10 B) Isosceles
7 C) Right
6 D) Scalene
6 E) I don't know

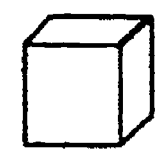
4.1 D 25. What is the measure of the angle being measured in the diagram?



78 A) 73°
6 B) 85°
3 C) 103°
11 D) 117°
2 E) I don't know.

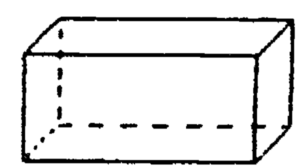
4.1 D 26. The heavy line shows one edge of the cube. How many edges does the cube have?

6 A) 8
2 B) 5
20 C) 9
70 D) 12
2 E) I don't know.



4.1 D 27. How many pairs of parallel planes are there in the following figure?

4 A) 2
17 B) 3
22 C) 4
51 D) 6
5 E) I don't know.



4.3 D 30. A path from P to Q can follow any route as long as it stays on the lines. How many paths from P to Q make exactly 3 turns?

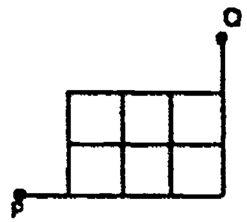
16 A) 0

23 B) 3

17 C) 5

16 D) 6

8 E) I don't know.



Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
18 A) 0 - 20%	12 A) It was done in a previous school year
24 B) 21 - 40%	35 B) It was done during this school year
32 C) 41 - 60%	18 C) It will be done later this year
20 D) 61 - 80%	12 D) It will be done in a subsequent year
7 E) 81 - 100%	23 E) It will not be done for reasons not listed here

4.2 A 25. Which one of the following names does not read the same if written on a card and held up to a mirror?

6 A) AVA

63 B) EVE

7 C) MOM

10 D) OTTO

14 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
17 A) 0 - 20%	23 A) It was done in a previous school year
22 B) 21 - 40%	28 B) It was done during this school year
26 C) 41 - 60%	19 C) It will be done later this year.
23 D) 61 - 80%	5 D) It will be done in a subsequent year
11 E) 81 - 100%	25 E) It will not be done for reasons not listed here

4.2 A 26. Which one of the following diagrams shows the reflection of the face in the line n?

15 A)

11 B)

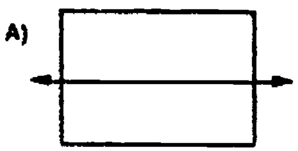
56 C)

10 D)

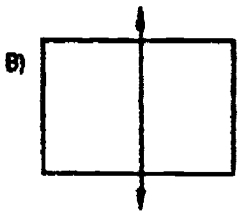
7 E) I don't know

4.2 B 29. Which one of the following figures shows all the lines of symmetry for a rectangle?

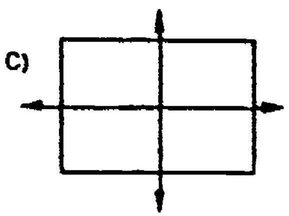
5 A)



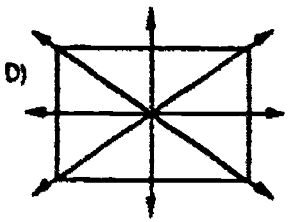
3 B)



48 C)

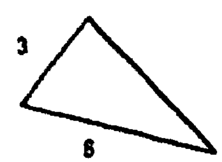


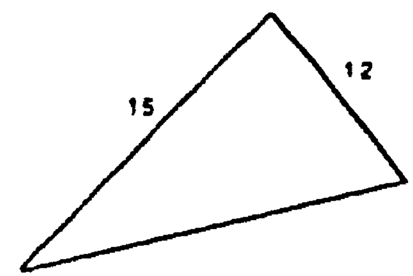
41 D)



3 E) I don't know.

4.2 A 28. The two triangles shown below are similar. What is the missing length on the large triangle?





7 A) $3\frac{3}{4}$

10 B) $7\frac{1}{2}$

45 C) 24

12 D) 30

25 E) I don't know

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
34 A) 0 - 20%	8 A) It was done in a previous school year
23 B) 21 - 40%	44 B) It was done during this school year
24 C) 41 - 60%	22 C) It will be done later this year. .
15 D) 61 - 80%	21 D) It will be done in a subsequent year
3 E) 81 - 100%	10 E) It will not be done for reasons not listed here

4.2 B 28. △ABC and △DEF are similar. If Angle A has a measure of 60°, what is the measure of Angle D?

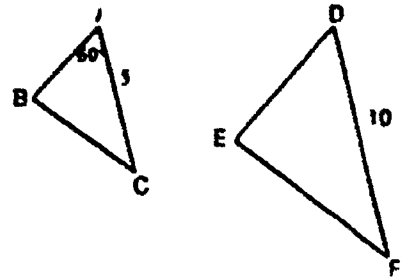
5 A) 30°

54 B) 60°

15 C) 90°

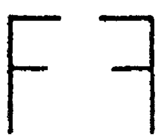
22 D) You cannot tell.

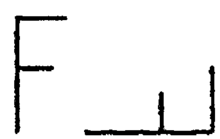
3 E) I don't know.



Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
16 A) 0 - 20%	5 A) It was done in a previous school year
17 B) 21 - 40%	63 B) It was done during this school year
26 C) 41 - 60%	29 C) It will be done later this year.
29 D) 61 - 80%	9 D) It will be done in a subsequent year.
12 E) 81 - 100%	4 E) It will not be done for reasons not listed here.

4.2 B 30. In which one of the following diagrams is the second figure a rotation of the first?

31 A) 

13 B) 

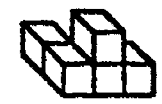
38 C) 

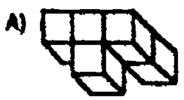
24 D) 

6 E) I don't know.

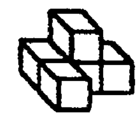
Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
33 A) 0 - 20%	12 A) It was done in a previous school year
24 B) 21 - 40%	26 B) It was done during this school year
23 C) 41 - 60%	33 C) It will be done later this year.
15 D) 61 - 80%	12 D) It will be done in a subsequent year
4 E) 81 - 100%	17 E) It will not be done for reasons not listed here

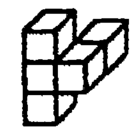
4.2 B 31. Which one of the following can be obtained by rotating the object below?



54 A) 

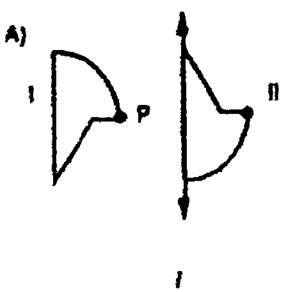
15 B) 

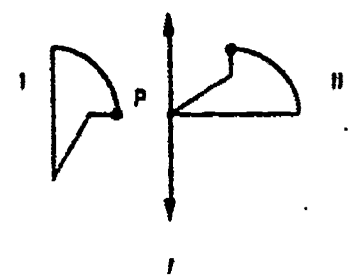
17 C) 

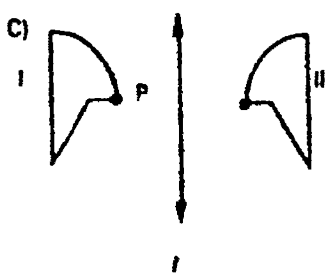
8 D) 

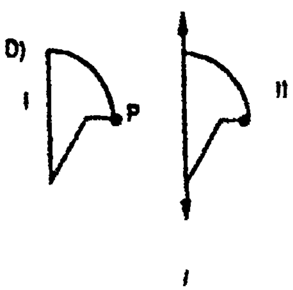
7 E) I don't know.

4.2 C 30. A figure is moved from position I to position II by a half-turn clockwise around point P and a reflection in line *l*. Which of the following shows that movement?

30 A) 

18 B) 

37 C) 

11 D) 

13 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
47 A) 0 - 20%	8 A) It was done in a previous school year
25 B) 21 - 40%	18 B) It was done during this school year
17 C) 41 - 60%	35 C) It will be done later this year
8 D) 61 - 80%	17 D) It will be done in a subsequent year
3 E) 81 - 100%	22 E) It will not be done for reasons not listed here.

4.2 C 31. A rectangular picture measuring 30 cm by 40 cm is enlarged for a billboard. The enlargement has an area of 48 m^2. What are the dimensions of the enlargement?

48 A) 6 m by 8 m

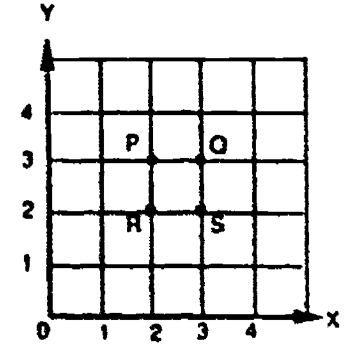
17 B) 4 m by 12 m

10 C) 16 m by 30 m

8 D) 15 m by 32 m

16 E) I don't know.

4.3 A 30. Which point has the coordinates (2, 3)?



46 A) P

4 B) Q

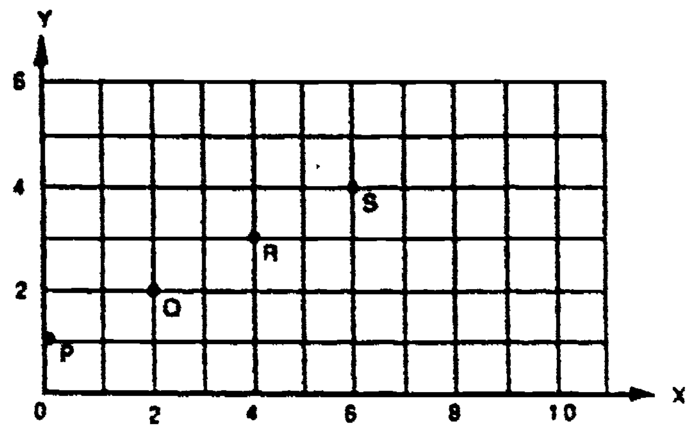
9 C) R

34 D) S

7 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
17 A) 0 - 20%	13 A) It was done in a previous school year
22 B) 21 - 40%	39 B) It was done during this school year
24 C) 41 - 60%	34 C) It will be done later this year
25 D) 61 - 80%	11 D) It will be done in a subsequent year
13 E) 81 - 100%	3 E) It will not be done for reasons not listed here

4.2 B 28. What are the coordinates of the next point in the pattern of points P, Q, R, S?



9 A) (4, 5)

6 B) (5, 5)

30 C) (5, 8)

34 D) (8, 5)

20 E) I don't know

4.3 C 28. Which line segment joins the points (1, 5) and (2, 10)?

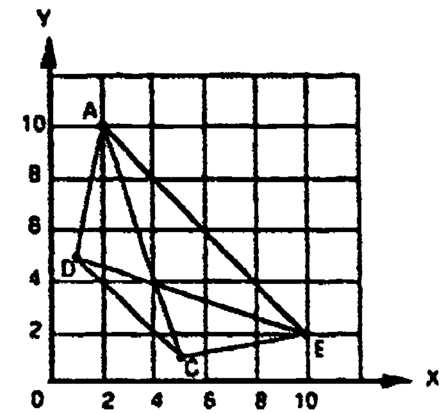
40 A) AD

19 B) CE

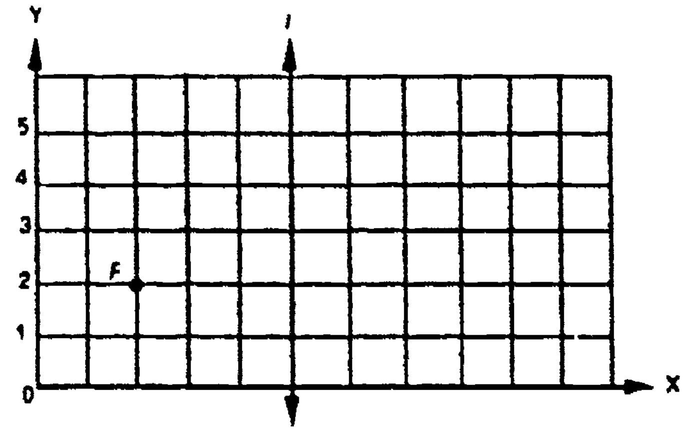
16 C) DE

15 D) CA

10 E) I don't know



4.3 C 29. What are the coordinates of the point P after it is flipped over the line *l* and then slid up two places?



7 A) (5, 0)

28 B) (5, 4)

7 C) (8, 0)

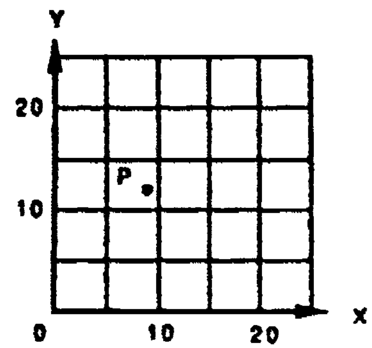
35 D) (8, 4)

21 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
47 A) 0 - 20%	8 A) It was done in a previous school year
19 B) 21 - 40%	21 B) It was done during this school year
20 C) 41 - 60%	39 C) It will be done later this year.
9 D) 61 - 80%	19 D) It will be done in a subsequent year
4 E) 81 - 100%	14 E) It will not be done for reasons not listed here

4.3 D 29. What are the coordinates of the point P?

6 A) (8, 8)
9 B) (12, 12)
37 C) (12, 8)
42 D) (8, 12)
6 E) I don't know.



Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
29 A) 0 - 20%	12 A) It was done in a previous school year
18 B) 21 - 40%	40 B) It was done during this school year
25 C) 41 - 60%	32 C) It will be done later this year.
26 D) 61 - 80%	12 D) It will be done in a subsequent year
12 E) 81 - 100%	4 E) It will not be done for reasons not listed here

5.1 A 34. Daley's Fruit Stand is on the highway 400 m west of Ash Street. Poplar Street is 1.2 km east of Ash Street along the highway. How far is Daley's Fruit Stand from Poplar Street?

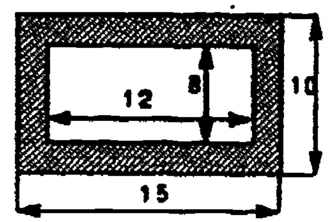
19 A) 401.2 m
14 B) 520 m
41 C) 1.6 km
11 D) 5.2 km
13 E) I don't know

5.1 B 32. The thickness of a dime is about

6 A) 1 cm
7 B) 1 dm
6 C) 1 m
77 D) 1 mm
3 E) I don't know

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
2 A) 0 - 20%	14 A) It was done in a previous school year
6 B) 21 - 40%	81 B) It was done during this school year
18 C) 41 - 60%	3 C) It will be done later this year
35 D) 61 - 80%	0 D) It will be done in a subsequent year
39 E) 81 - 100%	1 E) It will not be done for reasons not listed here

5.1 B 33. What is the area of the shaded portion of this figure?

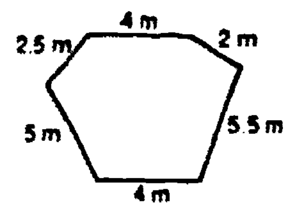


35 A) 54
28 B) 96
12 C) 120
10 D) 60
15 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
10 A) 0 - 20%	5 A) It was done in a previous school year
18 B) 21 - 40%	82 B) It was done during this school year
33 C) 41 - 60%	9 C) It will be done later this year
31 D) 61 - 80%	3 D) It will be done in a subsequent year.
9 E) 81 - 100%	1 E) It will not be done for reasons not listed here

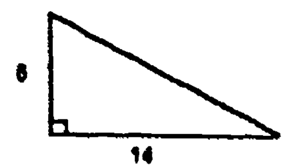
5.1 C 32. What is the perimeter of the figure below?

6 A) 22 m
73 B) 23 m
5 C) 27 m
13 D) 95 m
3 E) I don't know.



5.1 C 33. Find the area of this right triangle.

36 A) 42
14 B) 20
40 C) 84
4 D) 21
5 E) I don't know



Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
12 A) 0 - 20%	2 A) It was done in a previous school year
14 B) 21 - 40%	82 B) It was done during this school year
30 C) 41 - 60%	12 C) It will be done later this year.
32 D) 61 - 80%	3 D) It will be done in a subsequent year.
17 E) 81 - 100%	2 E) It will not be done for reasons not listed here

5.1 D 32. An ordinary classroom has an area of about

68 A) $50\ m^2$

18 B) $500\ m^2$

5 C) $5000\ m^2$

2 D) $50\ 000\ m^2$

6 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
7 A) 0 - 20%	7 A) It was done in a previous school year
18 B) 21 - 40%	83 B) It was done during this school year
35 C) 41 - 60%	5 C) It will be done later this year
31 D) 61 - 80%	2 D) It will be done in a subsequent year
9 E) 81 - 100%	2 E) It will not be done for reasons not listed here

5.2 A 31. A graduated cylinder contains 500 mL of water. A rock is placed in the cylinder and the water level rises to 683 mL. What is the volume of the rock?

72 A) $183\ cm^3$

5 B) $317\ cm^3$

7 C) $683\ cm^3$

7 D) $1183\ cm^3$

8 E) I don't know.

5.2 A 32. The excavation for a swimming pool is a rectangular hole that is 10 m long, 3 m wide, and 3 m deep. A dumptruck can carry $12\ m^3$ of fill. How many truckloads did it take to remove the fill from the excavation?

22 A) 3

19 B) 7

39 C) 8

9 D) 12

11 E) I don't know

5.2 A 35 A small car has a fuel tank that holds 35 L of gas. The car consumes 7.5 L for each 100 km driven. If a trip is 250 km, how much gas remains if the trip was started with a full tank?

32 A) 16.25 L

36 B) 18.75 L

8 C) 53.75 L

5 D) 1840 L

13 E) I don't know

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
10 A) 0 - 20%	2 A) It was done in a previous school year.
25 B) 21 - 40%	87 B) It was done during this school year
37 C) 41 - 60%	6 C) It will be done later this year.
24 D) 61 - 80%	3 D) It will be done in a subsequent year
3 E) 81 - 100%	2 E) It will not be done for reasons not listed here

5 2 B 34 Find the volume of this box.

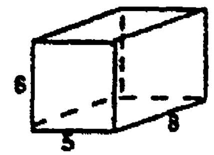
3 A) 30

8 B) 40

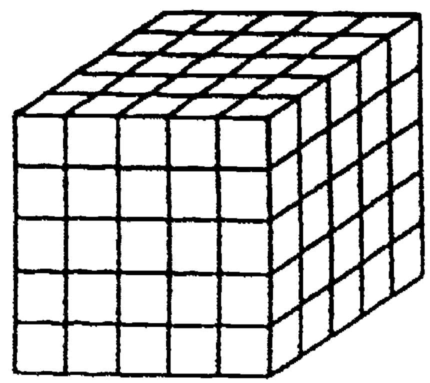
70 C) 240

12 D) 19

5 E) I don't know.



5.2 B 35 The object below is made up of cubes that are 1 cm on each side. The object is also hollow and the walls are only one cube thick. What is the volume of the empty space inside?



11 A) $9\ cm^3$

12 B) $18\ cm^3$

29 C) $27\ cm^3$

26 D) $64\ cm^3$

21 E) I don't know

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
21 A) 0 - 20%	6 A) It was done in a previous school year.
26 B) 21 - 40%	73 B) It was done during this school year
29 C) 41 - 60%	9 C) It will be done later this year.
19 D) 61 - 80%	6 D) It will be done in a subsequent year
5 E) 81 - 100%	6 E) It will not be done for reasons not listed here

5.3 A 33. 250 g is how many kilograms?

- 19 A) 25
- 4 B) 250
- 52 C) 0.25
- 21 D) 2.5
- 4 F) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
5 A) 0 - 20%	10 A) It was done in a previous school year
14 B) 21 - 40%	85 B) It was done during this school year
33 C) 41 - 60%	3 C) It will be done later this year.
36 D) 61 - 80%	0 D) It will be done in a subsequent year.
12 E) 81 - 100%	2 E) It will not be done for reasons not listed here

5.3 C 34. A nickel weighs about 5 g. What would be the mass of $5.00 in nickels?

- 28 A) 0.5 kg
- 20 B) 1 kg
- 24 C) 5 kg
- 21 D) 50 kg
- 5 E) I don't know

5.3 D 31. Which one of the following would have a mass of about a milligram?

- 3 A) A litre of milk
- 3 B) An orange
- 25 C) A grape
- 67 D) A grain of sand
- 2 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
9 A) 0 - 20%	13 A) It was done in a previous school year
14 B) 21 - 40%	77 B) It was done during this school year
27 C) 41 - 60%	6 C) It will be done later this year
31 D) 61 - 80%	2 D) It will be done in a subsequent year
20 E) 81 - 100%	2 E) It will not be done for reasons not listed here

5.3 D 33 Which of the following is the greatest length of time?

- 7 A) 15 000 seconds
- 31 B) 1 500 minutes
- 4 C) 10 hours
- 56 D) 1 day
- 2 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
6 A) 0 - 20%	29 A) It was done in a previous school year.
16 B) 21 - 40%	61 B) It was done during this school year.
35 C) 41 - 60%	4 C) It will be done later this year.
27 D) 61 - 80%	2 D) It will be done in a subsequent year.
17 E) 81 - 100%	4 E) It will not be done for reasons not listed here

5.3 D 34. The minute hand on a clock has made 16 complete revolutions since noon. Approximately what angle does the minute hand make with the hour hand?

- 15 A) 30°
- 18 B) 60°
- 29 C) 90°
- 23 D) 120°
- 14 E) I don't know.

6.1 A 36. Which one of the following stands for the product of a number and 6?

- 25 A) $y + 6$
- 5 B) $y - 6$
- 42 C) $6y$
- 13 D) $\frac{y}{6}$
- 13 E) I don't know

6.1 A 37 Of the following expressions, which one represents a number n increased by 5?

- 6 A) $5 - n$
- 69 B) $n + 5$
- 11 C) $5 < n$
- 6 D) $\frac{5}{n}$
- 7 E) I don't know

6.1 A 38. Gary works G hours for $7 per hour and Andy works A hours for $5 per hour. What is the total amount of money that they are paid?

13 A) 7A + 5G

13 B) 12(A + G)

10 C) 12AG

51 D) 7G + 5A

12 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
20 A) 0 - 20%	2 A) It was done in a previous school year
23 B) 21 - 40%	57 B) It was done during this school year
29 C) 41 - 60%	19 C) It will be done later this year.
22 D) 61 - 80%	15 D) It will be done in a subsequent year.
7 E) 81 - 100%	6 E) It will not be done for reasons not listed here

6.1 A 39. When the input is x the output is

INPUT	OUTPUT
3	7
4	9
5	11
6	13
7	15
8	17
.	.
.	.
.	.
x	__

11 A) 19

14 B) $2x - 1$

35 C) $2x + 1$

14 D) x

26 E) I don't know.

6.1 B 37. Which one of the following expressions represents twice a number less 5?

4 A) $2x + 10$

13 B) $2x - 10$

58 C) $2x - 5$

9 D) $2x + 5$

15 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
13 A) 0 - 20%	3 A) It was done in a previous school year
15 B) 21 - 40%	63 B) It was done during this school year
25 C) 41 - 60%	22 C) It will be done later this year
29 D) 61 - 80%	4 D) It will be done in a subsequent year
17 E) 81 - 100%	4 E) It will not be done for reasons not listed here

6.1 C 36. If $n = 5$, then $2n + 4 =$

61 A) 14

5 B) 18

8 C) 20

16 D) 11

10 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
12 A) 0 - 20%	2 A) It was done in a previous school year
13 B) 21 - 40%	21 B) It was done during this school year
20 C) 41 - 60%	20 C) It will be done later this year.
28 D) 61 - 80%	6 D) It will be done in a subsequent year
27 E) 81 - 100%	2 E) It will not be done for reasons not listed here

6.1 C 37 Evaluate $3a - 2b + c$ when $a = 5$, $b = 3$, and $c = 2$.

9 A) 7

8 B) 10

52 C) 11

16 D) 14

13 E) I don't know.

6.1 C 38. The number x is odd. What is the next odd number?

9 A) $x + 1$

35 B) $x + 2$

21 C) $x + 3$

16 D) $3x$

17 E) I don't know.

6.2 A 40. Solve $\frac{x}{8} = 16$

34 A) 2

9 B) 8

5 C) 24

45 D) 128

5 E) I don't know

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
8 A) 0 - 20%	1 A) It was done in a previous school year
13 B) 21 - 40%	76 B) It was done during this school year
20 C) 41 - 60%	14 C) It will be done later this year
36 D) 61 - 80%	5 D) It will be done in a subsequent year.
23 E) 81 - 100%	5 E) It will not be done for reasons not listed here

6.2 B 38. Solve: $x - 2 = 6$

9 A) $x = -4$

7 B) $x = -3$

8 C) $x = 3$

64 D) $x = 8$

11 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
12 A) 0 - 20%	3 A) It was done in a previous school year.
8 B) 21 - 40%	69 B) It was done during this school year
15 C) 41 - 60%	19 C) It will be done later this year.
30 D) 61 - 80%	7 D) It will be done in a subsequent year.
35 E) 81 - 100%	2 E) It will not be done for reasons not listed here

6.2 B 40. Look at the diagram below. A cat weighs 2 kg. How much does a dog weigh? (z = dog, + = cat)

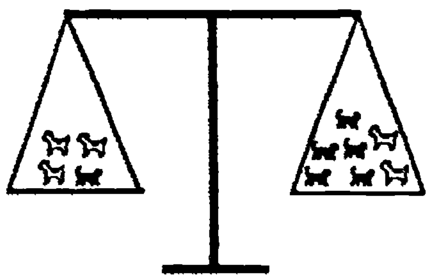
26 A) 4 kg

48 B) 8 kg

9 C) 16 kg

5 D) 24 kg

10 E) I don't know.



6.2 C 39. Bobby had \$15.00. He spent \$10.80 at the record store and received an amount c as change. Which of the following equations shows the correct relationship among \$15.00, \$10.80, and c?

8 A) $c - \$15.00 = \$10.80$

5 B) $c + \$15.00 = \$10.80$

6 C) $\$10.80 + \$15.00 = c$

72 D) $\$15.00 - \$10.80 = c$

8 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
8 A) 0 - 20%	6 A) It was done in a previous school year
11 B) 21 - 40%	72 B) It was done during this school year
23 C) 41 - 60%	16 C) It will be done later this year
35 D) 61 - 80%	5 D) It will be done in a subsequent year
29 E) 81 - 100%	2 E) It will not be done for reasons not listed here

6.2 D 36. Which one of the following is the same as "18 more than a number equals 44"?

14 A) $18n = 44$

10 B) $\frac{18}{n} = 44$

48 C) $n + 18 = 44$

11 D) $n = 18 + 44$

17 E) I don't know.

6.2 D 37. Solve: $n + 3 = 9$

10 A) $n = -6$

3 B) $n = -3$

9 C) $n = 3$

74 D) $n = 6$

4 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
6 A) 0 - 20%	6 A) It was done in a previous school year.
5 B) 21 - 40%	76 B) It was done during this school year.
19 C) 41 - 60%	13 C) It will be done later this year.
27 D) 61 - 80%	3 D) It will be done in a subsequent year.
53 E) 81 - 100%	2 E) It will not be done for reasons not listed here.

6.2 D 38. Solve: $17x = 119$

68 A) $x = 7$

5 B) $x = -112$

9 C) $x = 102$

5 D) $x = 2023$

11 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
13 A) 0 - 20%	3 A) It was done in a previous school year.
14 B) 21 - 40%	65 B) It was done during this school year.
22 C) 41 - 60%	22 C) It will be done later this year.
31 D) 61 - 80%	8 D) It will be done in a subsequent year.
20 E) 81 - 100%	2 E) It will not be done for reasons not listed here

6.2 D 39. Which one of the following is the first step in solving the equation $4x = 12$?

- 7 A) Subtract 4 from both sides of the equation.
- 6 B) Add 4 to both sides of the equation.
- 25 C) Multiply 3 on both sides of the equation.
- 42 D) Divide both sides of the equation by 4.
- 14 E) I don't know.

NS A 20. About how many is a million?

- 29 A) The number of hairs on your head
- 9 B) The number of grains of sand on a beach
- 20 C) The number of people that could be packed onto a soccer field standing up
- 36 D) The number of tennis balls needed to fill a classroom
- 7 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
11 A) 0 - 20%	21 A) It was done in a previous school year.
23 B) 21 - 40%	45 B) It was done during this school year.
32 C) 41 - 60%	7 C) It will be done later this year.
21 D) 61 - 80%	3 D) It will be done in a subsequent year.
13 E) 81 - 100%	24 E) It will not be done for reasons not listed here

NS B 19. How high would a stack of one million pennies be?

- 25 A) 2 m
- 21 B) 200 m
- 19 C) 2 000 m
- 13 D) 20 000 m
- 21 E) I don't know.

NS C 19. About how much does a horse weigh?

- 2 A) 4 kg
- 7 B) 40 kg
- 62 C) 400 kg
- 24 D) 4000 kg
- 7 E) I don't know.

NS D 19. If you divide any positive number by a number greater than 2, then the answer will be

- 32 A) less than half the original number.
- 20 B) more than half the original number.
- 9 C) a fraction.
- 22 D) impossible to predict.
- 16 E) I don't know.

APPENDIX G

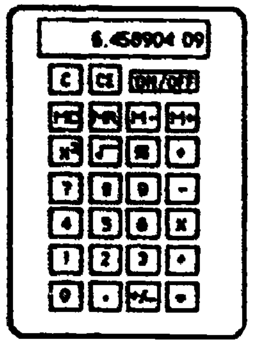
Grade 10 Student Achievement Items

1.1 A 1. Simplify: $30 - 4(8 - 2)$

2 A) 0
8 B) 20
33 C) 156
53 D) 6
3 E) I don't know.

1.1 A 2. Someone has just multiplied 6540 by 987 600 on the calculator. The calculator with the answer displayed is shown below. The product of the two numbers is

35 A) 6 458 904 000
10 B) 6 458 904 009
32 C) $6.458\,904^9$
6 D) 645 890 400
16 E) I don't know.



Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
19 A) 0 - 20%	33 A) It was done in a previous school year
17 B) 21 - 40%	47 B) It was done during this school year.
25 C) 41 - 60%	5 C) It will be done later this year.
22 D) 61 - 80%	5 D) It will be done in a subsequent year.
17 E) 81 - 100%	10 E) It will not be done for reasons not listed here

1.1 A 21. Evaluate: $(2^3)^2$

13 A) 12
12 B) 32
62 C) 64
7 D) 36
5 E) I don't know

1.1 A 22. Simplify: $\frac{2 \times 3^3}{4 \times 3^2}$

12 A) $\frac{3}{4}$
40 B) $\frac{3}{2}$
16 C) $\frac{2}{3}$
11 D) $\frac{4}{3}$
21 E) I don't know.

1.1 B 2. A salesman receives 20% of the retail value of his sales as a commission. What must his total sales be to earn a commission of \$60?

25 A) \$1200
5 B) \$ 800
57 C) \$ 300
6 D) \$ 240
7 E) I don't know.

1.1 B 21. What is the value of $2^3 \times 3^2$?

76 A) 72
9 B) 36
7 C) 54
4 D) 48
4 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
3 A) 0 - 20%	15 A) It was done in a previous school year.
4 B) 21 - 40%	83 B) It was done during this school year.
13 C) 41 - 60%	1 C) It will be done later this year.
35 D) 61 - 80%	1 D) It will be done in a subsequent year.
44 E) 81 - 100%	1 E) It will not be done for reasons not listed here

1.1 B 22. Evaluate: $4^3 \times 4^{-2}$

21 A) 4

12 B) $\frac{1}{4}$

19 C) -4

13 D) $-\frac{1}{4}$

33 E) I don't know.

1.1 B 23. Simplify: $9 + 21 \div 3 + 4$

4 A) 12

19 B) 14

13 C) $4\frac{2}{7}$

60 D) 20

3 E) I don't know.

1.1 C 1. Mrs. Schmidt works in a local factory for $6.00 per hour, plus time and one-half after 40 hours. Last week she worked 45 hours. How much did she earn?

3 A) $240

22 B) $270

67 C) $285

4 D) $405

3 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
2 A) 0 - 20%	51 A) It was done in a previous school year.
7 B) 21 - 40%	47 B) It was done during this school year
22 C) 41 - 60%	2 C) It will be done later this year.
45 D) 61 - 80%	2 D) It will be done in a subsequent year.
23 E) 81 - 100%	3 E) It will not be done for reasons not listed here.

1.1 C 22. Evaluate: $(3^{-1})^2$

23 A) $\frac{1}{9}$

24 B) -9

16 C) $-\frac{1}{9}$

20 D) 9

18 E) I don't know.

1.1 C 23. Evaluate: $\frac{6^2}{3}$

61 A) 12

19 B) 4

6 C) 108

5 D) 6

9 E) I don't know.

1.1 D 1. A used automobile can be bought for cash for $2850, or on credit with a down payment of $400 and $80 a month for three years. How much more would a person pay by buying on credit than by buying the car for cash?

12 A) $ 3280

7 B) $ 640

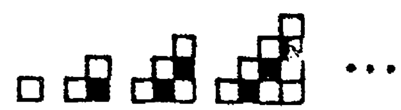
66 C) $ 430

5 D) $ 400

9 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
10 A) 0 - 20%	32 A) It was done in a previous school year.
21 B) 21 - 40%	49 B) It was done during this school year.
26 C) 41 - 60%	4 C) It will be done later this year
29 D) 61 - 80%	7 D) It will be done in a subsequent year.
12 E) 81 - 100%	6 E) It will not be done for reasons not listed here

1.1 D 2. How many white squares will there be in the 10th figure in the following pattern?



17 A) 45

38 B) 46

18 C) 55

6 D) 512

21 E) I don't know.

3.3?

310

1.1 D 22. Simplify: 10 + 35 + 5 + 2

58 A) 19

28 B) 11

4 C) 15

6 D) $6\frac{3}{7}$

4 E) I don't know.

1.1 D 23. Evaluate: $(2^{-2})^{-2}$

39 A) −16

13 B) 0

13 C) $\frac{1}{16}$

21 D) 16

14 E) I don't know.

1.2 A 3. Which number is largest?

24 A) $\frac{2}{3}$

52 B) $\frac{4}{5}$

13 C) $\frac{3}{4}$

8 D) $\frac{5}{8}$

2 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
2 A) 0 - 20%	53 A) It was done in a previous school year
7 B) 21 - 40%	36 B) It was done during this school year
31 C) 41 - 60%	0 C) It will be done later this year.
36 D) 61 - 80%	6 D) It will be done in a subsequent year.
34 E) 81 - 100%	2 E) It will not be done for reasons not listed here

1.2 A 4. If the city's property tax is \$29.87 per \$1000 of assessed value, the tax on a property assessed at \$14 900 would be closest to which one of the following amounts?

4 A) \$400

13 B) \$420

56 C) \$450

16 D) \$470

12 E) I don't know.

1.2 A 24. Subtract: $0.7 - \frac{3}{5}$

12 A) $-\frac{1}{10}$

34 B) $\frac{1}{10}$

17 C) $\frac{4}{5}$

8 D) $\frac{13}{10}$

28 E) I don't know.

1.2 A 25. Evaluate: $(4\frac{2}{3}) \times (3\frac{3}{4})$

23 A) $12\frac{1}{2}$

13 B) $7\frac{1}{2}$

21 C) $17\frac{1}{2}$

24 D) $12\frac{5}{12}$

18 E) I don't know.

1.2 A 26. Estimate the answer to $12\frac{2}{35} \times 5\frac{16}{17} \times 10$

(Do not take time to perform the calculation.)

6 A) 27

34 B) 600

29 C) 720

16 D) 780

14 E) I don't know.

1.2 A 27. Jane gave the storekeeper a twenty dollar bill for a purchase of \$5.97. She also paid \$4.08 for the articles her brothers bought. How much change should Jane get back?

25 A) \$9.95

11 B) \$10.05

6 C) \$14.03

4 D) \$15.96

3 E) I don't know

1.2 A 28. The scientific notation for the product $(9 \times 10^3)(1.2 \times 10^5)$ is

8 A) 1.02×10^8

36 B) 10.8×10^8

16 C) 1.08×10^9

14 D) 10.2×10^{15}

23 E) I don't know.

1.2 A 29. The sales tax is 5%. How much would the sales tax be on a new car that costs $6750.00?

8 A) $675.00

55 B) $337.50

12 C) $ 67.50

16 D) $ 33.75

7 E) I don't know.

1.2 B 4. John and Jean are planning a vacation trip to Winnipeg next summer. They estimate that they will drive a total of about 6500 km. Their car uses 11 L/100 km. <u>Approximately</u> how many litres of gasoline will they need for the trip?

7 A) 60

8 B) 70

19 C) 600

61 D) 700

6 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
3 A) 0 - 20%	40 A) It was done in a previous school year.
11 B) 21 - 40%	34 B) It was done during this school year.
39 C) 41 - 60%	1 C) It will be done later this year.
31 D) 61 - 80%	9 D) It will be done in a subsequent year.
19 E) 81 - 100%	4 E) It will not be done for reasons not listed here.

1.2 B 24. Evaluate: $5\frac{3}{4} - 3\frac{1}{2}$

14 A) $2\frac{1}{2}$

11 B) 8

55 C) $2\frac{1}{4}$

7 D) 3

11 E) I don't know.

1.2 B 25. Simplify: $\frac{2}{3} - (\frac{5}{6} + \frac{1}{2})$

26 A) $-\frac{2}{3}$

14 B) $-\frac{4}{11}$

19 C) $\frac{1}{3}$

17 D) $\frac{4}{5}$

22 E) I don't know.

1.2 B 26. Which one of the following is equivalent to $\frac{3}{4}$% ?

10 A) 0.0075

12 B) 0.34

64 C) 0.75

7 D) 1.33

5 E) I don't know.

1.2 B 27. Which one of the following is equivalent to $1.\dot{6}$% ?

41 A) $0.01\dot{6}$

20 B) $0.1\dot{6}$

25 C) $1.\dot{6}$

6 D) $166.\dot{6}$

7 E) I don't know.

1.2 B 28. When written in scientific notation, the quotient for $(2.4 \times 10^7) \div (3 \times 10^4)$ is

7 A) 0.8×10^{-3}

9 B) 8.0×10^{-3}

18 C) 8.0×10^2

34 D) 0.8×10^3

30 E) I don't know.

1.2 B 29. Mr. Thomas dug $12\frac{1}{2}$ rows of potatoes in $2\frac{1}{2}$ h. At that rate how many rows of potatoes did he dig in one hour?

6 A) $\frac{1}{5}$

38 B) 5

38 C) 8

8 D) $31\frac{1}{4}$

8 E) I don't know.

1.2 C 4. Wendy bought 3 record albums on sale. The regular price was \$7.24 each and the sale price was \$1.50 off each record. If she paid 69¢ sales tax on her total purchase, how much money did she spend?

6 A) \$17.22

79 B) \$17.91

5 C) \$21.72

4 D) \$22.91

3 E) I don't know.

1.2 C 24. Linda's new bike cost \$159.99 and the sales tax was 5%. How much did she pay including tax?

16 A) \$164.99

57 B) \$167.99

10 C) \$172.98

7 D) \$177.99

8 E) I don't know.

1.2 C 25. Written as a fraction in lowest terms, $\frac{1}{4}\%$ =

8 A) $\frac{1}{4000}$

25 B) $\frac{1}{400}$

33 C) $\frac{1}{40}$

43 D) $\frac{1}{4}$

10 E) I don't know.

1.2 C 26. Evaluate: $4\frac{1}{5} + 3\frac{2}{5}$

17 A) $7\frac{3}{10}$

13 B) $\frac{38}{10}$

6 C) 2

55 D) $7\frac{3}{5}$

7 E) I don't know.

1.2 C 27. At a party the ratio of boys to girls was 2 to 1. What percent of the people at the party were girls?

13 A) $66\frac{2}{3}\%$

28 B) 50%

38 C) $33\frac{1}{3}\%$

8 D) 200%

11 E) I don't know.

1.2 C 28. Divide: $1\frac{1}{3} \div 2\frac{2}{3}$

11 A) $\frac{1}{3}$

31 B) $\frac{1}{2}$

30 C) $1\frac{1}{3}$

11 D) $\frac{32}{9}$

16 E) I don't know.

1.2 C 29. Multiply: $3\frac{1}{2} \times 2\frac{1}{7}$

7 A) $\frac{6}{14}$

11 B) $5\frac{9}{14}$

45 C) $6\frac{1}{14}$

21 D) $7\frac{1}{2}$

11 E) I don't know.

1.2 D 4. In a school election with three candidates, Mike received 120 votes, Lawrence received 30 votes, and Lesley received 50 votes. What percent of the total vote did Mike receive?

1 A) 30%

5 B) 40%

84 C) 60%

7 D) 120%

3 E) I don't know.

1.2 D 24. Written as a decimal, 20% equals

61 A) 0.2

11 B) 0.02

7 C) 2.0

17 D) 20.0

3 E) I don't know.

1.2 D 25. Write $\frac{3}{8}$ as a decimal.

5 A) 0.3

13 B) 0.24

58 C) 0.375

13 D) $2.6\dot{6}$

10 E) I don't know.

1.2 D 26. The scientific notation for 634.78 is

15 A) $0.634\,78 \times 10^{-3}$

14 B) 6.3478×10^{-2}

21 C) 63.478×10

23 D) 6.3478×10^{2}

19 E) I don't know.

1.2 D 27. A marathon runner covers 42 km in $2\frac{1}{2}$ hours. His average speed is

12 A) 8.4 km/h

56 B) 16.8 km/h

13 C) 25.2 km/h

6 D) 33.6 km/h

13 E) I don't know.

1.2 D 29. Find the missing term: $\frac{2}{8} = 1\frac{1}{3}$

14 A) $\frac{3}{2}$

10 B) $\frac{8}{3}$

28 C) 3

22 D) 8

25 E) I don't know.

1.3 A 41. Give the answer in simplest radical form.

$$\sqrt{48} - \sqrt{27} + \sqrt{12}$$

7 A) $4\sqrt{2}$

34 B) $\sqrt{33}$

6 C) 3

41 D) $3\sqrt{3}$

12 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
23 A) 0 - 20%	3 A) It was done in a previous school year
13 B) 21 - 40%	76 B) It was done during this school year
28 C) 41 - 60%	2 C) It will be done later this year
27 D) 61 - 80%	8 D) It will be done in a subsequent year.
9 E) 81 - 100%	11 E) It will not be done for reasons not listed here

1.3 A 42. Find the difference in simplest radical form.

$$\sqrt{20} - \sqrt{5}$$

32 A) $\sqrt{15}$

33 B) $\sqrt{5}$

16 C) $3\sqrt{5}$

13 D) 2

7 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
22 A) 0 - 20%	3 A) It was done in a previous school year
14 B) 21 - 40%	75 B) It was done during this school year
25 C) 41 - 60%	2 C) It will be done later this year.
29 D) 61 - 80%	9 D) It will be done in a subsequent year
12 E) 81 - 100%	11 E) It will not be done for reasons not listed here

1.3 B 41. Find the sum in simplest radical form.

$$\sqrt{32} + \sqrt{8}$$

28 A) $\sqrt{40}$

16 B) $2\sqrt{10}$

42 C) $6\sqrt{2}$

6 D) $\sqrt{72}$

8 E) I don't know.

1.3 B 42. Find the quotient in simplest radical form.

$$\frac{6\sqrt{20}}{2\sqrt{10}}$$

9 A) $4\sqrt{10}$

60 B) $3\sqrt{2}$

8 C) $4\sqrt{2}$

11 D) $3\sqrt{10}$

12 E) I don't know

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
17 A) 0 - 20%	3 A) It was done in a previous school year.
12 B) 21 - 40%	81 B) It was done during this school year
30 C) 41 - 60%	3 C) It will be done later this year.
31 D) 61 - 80%	6 D) It will be done in a subsequent year
11 E) 81 - 100%	9 E) It will not be done for reasons not listed here

1.3 C 41. Find the sum in simplest radical form

$$\sqrt{12} + \sqrt{27}$$

48 A) $5\sqrt{3}$

31 B) $\sqrt{39}$

4 C) 15

8 D) $3\sqrt{6}$

9 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
15 A) 0 - 20%	3 A) It was done in a previous school year
9 B) 21 - 40%	84 B) It was done during this school year
33 C) 41 - 60%	2 C) It will be done later this year.
32 D) 61 - 80%	3 D) It will be done in a subsequent year
12 E) 81 - 100%	8 E) It will not be done for reasons not listed here

1 3 D 41 Write in simplest radical form

$$3\sqrt{48}$$

52 A) $12\sqrt{3}$

9 B) $7\sqrt{3}$

18 C) $6\sqrt{12}$

3 D) $5\sqrt{12}$

19 E) I don't know

2.1 A 30 The petals on 100 flowers of different kinds were carefully counted, and the results shown in the table below.

How many of the flowers had fewer than 19 petals?

9 A) 8

12 B) 25

59 C) 75

6 D) 93

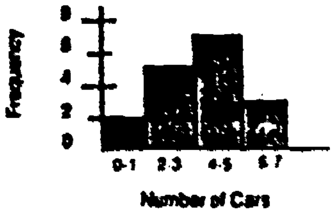
11 E) I don't know.

No. of Petals	Frequency
10-12	5
13-15	22
16-18	48
19-21	18
22-24	7

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
13 A) 0 - 20%	23 A) It was done in a previous school year
13 B) 21 - 40%	45 B) It was done during this school year
23 C) 41 - 60%	15 C) It will be done later this year
31 D) 61 - 80%	4 D) It will be done in a subsequent year
70 E) 81 - 100%	12 E) It will not be done for reasons not listed here

2.1 C 30. A table and a graph of the same data are shown below. What is the value of x?

Number of Cars	Frequency
0 or 1	2
2 or 3	x
4 or 5	7
6 or 7	3



5 A) 3

10 B) 4

22 C) 5

5 D) 6

6 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
9 A) 0 - 20%	29 A) It was done in a previous school year
10 B) 21 - 40%	38 B) It was done during this school year.
19 C) 41 - 60%	28 C) It will be done later this year.
27 D) 61 - 80%	5 D) It will be done in a subsequent year.
35 E) 81 - 100%	10 E) It will not be done for reasons not listed here

2.1 D 30. A team scored an average of 3 points per game for 5 games. How many points altogether were scored in the 5 games?

4 A) 5

81 B) 15

5 C) 25

4 D) 75

4 E) I don't know.

2.2 A 5. Using the tax table shown below, find the total tax payable (federal and provincial) on a taxable income of $10 358.82.

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

23 A) $751.70

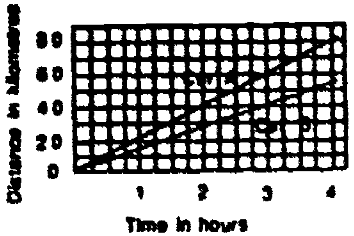
10 B) $1508.00

50 C) $2259.70

4 D) $2256.90

11 E) I don't know

2.2 A 31. The distance travelled by two cars during a period of 4 hours is shown in the graph below. How much longer does it take Car B to go 50 km than it does for Car A to go 50 km?



12 A) 1 hour 15 minutes

23 B) 1 hour 30 minutes

14 C) 2 hours

15 D) 2 hours 30 minutes

14 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
18 A) 0 - 20%	25 A) It was done in a previous school year
29 B) 21 - 40%	48 B) It was done during this school year.
30 C) 41 - 60%	13 C) It will be done later this year.
29 D) 61 - 80%	3 D) It will be done in a subsequent year.
13 E) 81 - 100%	9 E) It will not be done for reasons not listed here

2.2 A 32. Joe had three test scores of 78, 76, and 74, while Mary had scores of 72, 82 and 74. How did Joe's average score compare with Mary's?

5 A) Joe's was 1 point higher.

10 B) Joe's was 1 point lower.

68 C) Both averages were the same.

8 D) Joe's was 2 points higher.

6 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
3 A) 0 - 20%	37 A) It was done in a previous school year.
13 B) 21 - 40%	53 B) It was done during this school year.
22 C) 41 - 60%	8 C) It will be done later this year.
35 D) 61 - 80%	1 D) It will be done in a subsequent year.
25 E) 81 - 100%	2 E) It will not be done for reasons not listed here.

2.2 A 43. Which one of the following types of graphs would be most appropriate to show temperature changes?

2 A) Pie graph

5 B) Pictograph

82 C) Line graph

4 D) Stem and leaf plot

3 E) I don't know.

2.2 B 5. How many more passengers used the airports in January than in April?

AIRLINE PASSENGERS FOR FIRST SIX MONTHS OF THE YEAR

Airports	Hundreds of Passengers per Month Jan.	Feb.	Mar.	Apr.	May	June	Total
Bay City	9	3	5	7	2	4	30
Camden	6	8	1	5	8	2	30
Dover	8	5	9	6	6	3	37
Fiske	5	6	6	1	3	7	28
Grange	1	2	3	6	7	10	29
TOTAL	29	24	24	25	26	26	154

2 A) 29

2 B) 2900

65 C) 4

30 D) 400

2 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
2 A) 0 - 20%	39 A) It was done in a previous school year.
6 B) 21 - 40%	44 B) It was done during this school year.
16 C) 41 - 60%	9 C) It will be done later this year.
32 D) 61 - 80%	1 D) It will be done in a subsequent year.
44 E) 81 - 100%	8 E) It will not be done for reasons not listed here

2.2 B 31. The table below lists the number of trees planted along a highway in a week.

Days of the Week	Mon	Tues	Wed	Thurs	Fri
Number of Trees Planted	80	50	60	90	70

On the diagram below, the graph for the first two days' plantings has been drawn. If the graph were completed, which point would indicate the top of the bar for Thursday?

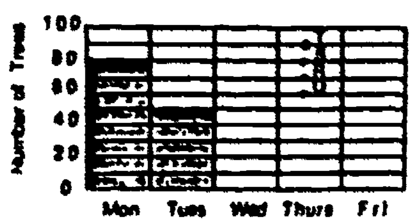
7 A) Q

8 B) R

13 C) S

62 D) T

7 E) I don't know.



2.2 B 43. The points R, S, T, and W shown on the graph below, were obtained experimentally to describe a theoretical linear relationship. Which point is most likely to have the greatest experimental error?

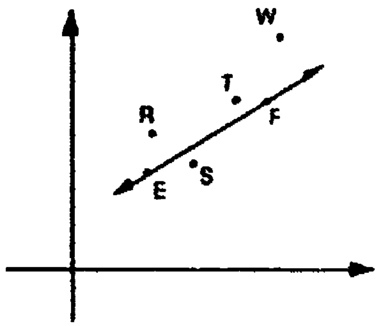
24 A) R

13 B) S

6 C) T

43 D) W

13 E) I don't know.



2.2 C 5. What is the mean of the following numbers?

2, 2, 2, 3, 4, 5, 10

14 A) 3

21 B) 2

6 C) 10

34 D) 4

24 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
15 A) 0 - 20%	31 A) It was done in a previous school year.
15 B) 21 - 40%	37 B) It was done during this school year.
23 C) 41 - 60%	21 C) It will be done later this year.
25 D) 61 - 80%	3 D) It will be done in a subsequent year.
22 E) 81 - 100%	9 E) It will not be done for reasons not listed here

2.2 C 6. From the graph below, the temperature at a depth of 2.5 km is closest to

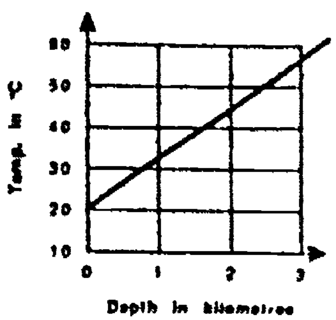
3 A) 30°C

5 B) 40°C

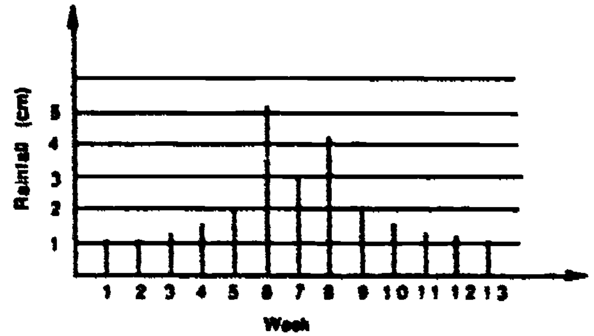
88 C) 50°C

2 D) 60°C

2 E) I don't know.



2.2 C 31. In the graph below, rainfall in centimetres is plotted for 13 weeks. The average weekly rainfall during the period is approximately



28 A) 1 cm

40 B) 2 cm

16 C) 3 cm

8 D) 4 cm

6 E) I don't know.

2.2 C 32. The table below shows scores for a class on a 10-point test. How many in the class made a score GREATER than 7?

Test Score	Tally	Frequency
4		1
5		3
6		6
7		2
8		4
9		3
10		1

16 A) 2

35 B) 8

29 C) 10

6 D) 12

11 E) I don't know

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
7 A) 0 - 20%	30 A) It was done in a previous school year.
10 B) 21 - 40%	44 B) It was done during this school year.
16 C) 41 - 60%	14 C) It will be done later this year.
37 D) 61 - 80%	3 D) It will be done in a subsequent year.
29 E) 81 - 100%	10 E) It will not be done for reasons not listed here.

2.2 C 43. Points A, B, and C are plotted in the diagram below. If these points are supposed to lie on the same line, which one of the following statements can we conclude is true?

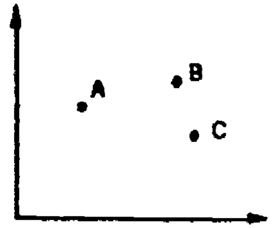
4 A) Point A is incorrectly plotted.

5 B) Point B is incorrectly plotted.

7 C) Point C is incorrectly plotted.

81 D) Any one of points A, B, or C is incorrectly plotted.

3 E) I don't know.



2.2 D 6. How many passengers used the airport in June?

AIRLINE PASSENGERS FOR FIRST SIX MONTHS OF THE YEAR

Airports	Hundreds of Passengers per Month						Total
	Jan.	Feb.	Mar.	Apr.	May	June	
Bay City	9	3	5	7	2	4	30
Camden	6	8	1	5	8	2	30
Dover	8	5	9	6	6	3	37
Fiske	5	6	6	1	3	7	28
Grange	1	2	3	6	7	10	29
TOTAL	29	24	24	25	26	26	154

A) 7

B) 26 Deleted

C) 700 from

D) 2600 test

E) I don't know.

2.2 D 31. The distance travelled by two cars during a period of four hours is shown in the graph below. Three hours after starting, how many kilometres is car A ahead of car B?

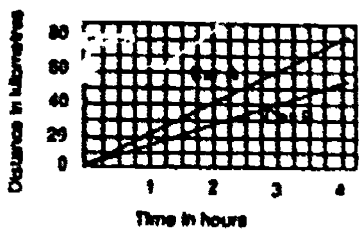
10 A) 2

8 B) 10

13 C) 15

56 D) 20

11 E) I don't know



2.2 D 32. The graph shows the distance travelled by a tractor during a period of four hours. How fast is the tractor moving?

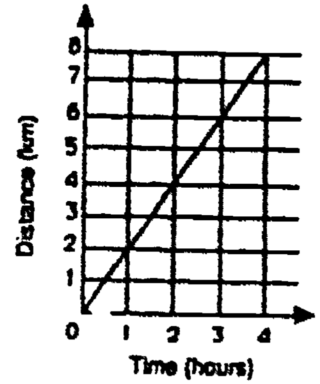
6 A) 1 km/h

53 B) 2 km/h

10 C) 4 km/h

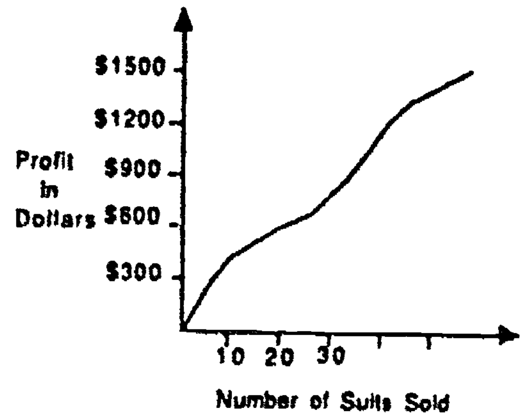
23 D) 8 km/h

6 E) I don't know.



2.2 D 43. If the relationship shown in the graph below continues between profit and the number of suits sold, what will be the approximate profit for the sale of 35 suits?

Profit for a B.C. Suit Manufacturer



3 A) $600

21 B) $900

59 C) $1200

4 D) $1500

3 E) I don't know

2.3 A 6. A bag contains 3 red marbles, 2 white marbles, and 20 black marbles. What is the probability of randomly choosing a white marble?

32 A) 0.08

11 B) 0.5

7 C) 0.92

9 D) 2.0

14 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
44 A) 0 - 20%	33 A) It was done in a previous school year
22 B) 21 - 40%	10 B) It was done during this school year.
19 C) 41 - 60%	20 C) It will be done later this year.
11 D) 61 - 80%	13 D) It will be done in a subsequent year
5 E) 81 - 100%	24 E) It will not be done for reasons not listed here

2.3 A 7. Two dice are rolled. What is the probability of rolling a total of 5?

15 A) $\frac{1}{9}$

27 B) $\frac{5}{36}$

16 C) $\frac{1}{18}$

18 D) $\frac{2}{9}$

24 E) I don't know.

2.3 A 8. Mike flips two quarters. What is the probability that they both land heads?

45 A) $\frac{1}{4}$

9 B) $\frac{1}{3}$

38 C) $\frac{1}{2}$

3 D) $\frac{2}{3}$

5 E) I don't know.

2.3 A 44. A collection of coins consists of 5 quarters, 2 dimes, 6 pennies, 3 nickels, and 4 one-dollar coins. What is the likelihood that if one is drawn at random, it will be a nickel?

63 A) 15%

12 B) 12%

6 C) 25%

10 D) 10%

8 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
39 A) 0 - 20%	36 A) It was done in a previous school year
24 B) 21 - 40%	10 B) It was done during this school year.
20 C) 41 - 60%	20 C) It will be done later this year.
13 D) 61 - 80%	12 D) It will be done in a subsequent year.
4 E) 81 - 100%	23 E) It will not be done for reasons not listed here

3.1 A 9. Two angles are both equal and supplementary. What is the measure of each?

51 A) 90°

17 B) 45°

21 C) 180°

2 D) $22\frac{1}{2}$°

8 E) I don't know.

3.1 A 10. The measure of ∠ A is twice its complement. ∠ A is equal to

28 A) 120°

31 B) 60°

11 C) 30°

3 D) 15°

25 E) I don't know

3.1 B 9. The measure of ∠ B is 70° If AB = CB then the measure of ∠ A is

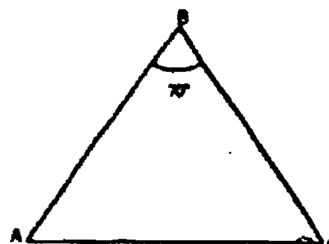
65 A) 55°

4 B) 60°

21 C) 70°

6 D) 110°

3 E) I don't know



3.1 B 10. The measure of ∠ X is

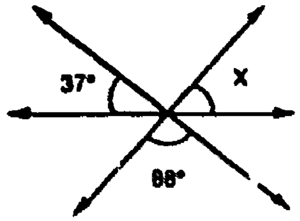
16 A) 37°

21 B) 55°

5 C) 85°

3 D) 88°

5 E) I don't know.



Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
13 A) 0 - 20%	26 A) It was done in a previous school year
13 B) 21 - 40%	52 B) It was done during this school year
17 C) 41 - 60%	13 C) It will be done later this year.
30 D) 61 - 80%	2 D) It will be done in a subsequent year.
27 E) 81 - 100%	6 E) It will not be done for reasons not listed here

3.1 C 9. ABCD is a parallelogram. If ∠ A = 105° determine ∠ B.

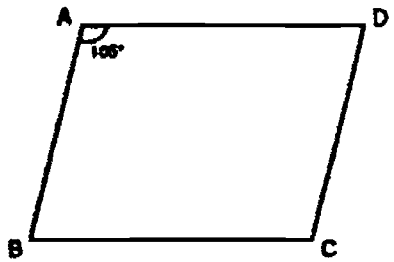
62 A) 75°

6 B) 95°

19 C) 105°

3 D) 255°

4 E) I don't know.



Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
15 A) 0 - 20%	26 A) It was done in a previous school year
14 B) 21 - 40%	51 B) It was done during this school year
20 C) 41 - 60%	14 C) It will be done later this year.
27 D) 61 - 80%	2 D) It will be done in a subsequent year
23 E) 81 - 100%	6 E) It will not be done for reasons not listed here.

3.1 C 10. Angles X and Y in the figure below are complementary. If the measure of angle X is 24° less than the measure of angle Y, then angle X is

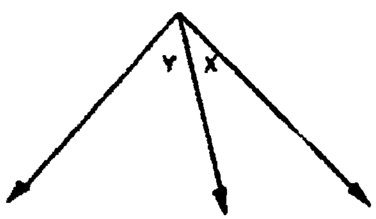
15 A) 48°

11 B) 23°

17 C) 57°

31 D) 33°

26 E) I don't know



3.1 D 9. Which two angles are each supplementary to ∠ 4?

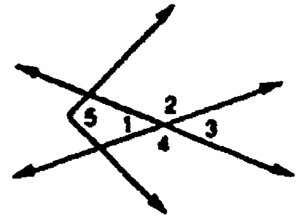
6 A) ∠ 1 and ∠ 2

9 B) ∠ 2 and ∠ 3

6 C) ∠ 5 and ∠ 1

72 D) ∠ 1 and ∠ 3

7 E) I don't know.



3.1 D 10. Δ ABC is a right triangle and ΔABD is equilateral. ∠ BDC =

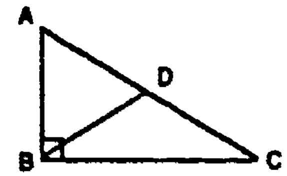
11 A) 90°

48 B) 120°

12 C) 135°

16 D) between 120° and 135°

13 E) I don't know.



3.2 A 11. When Joe walks from his house to Kelly's house, he follows the path through the open field. How far does he walk?

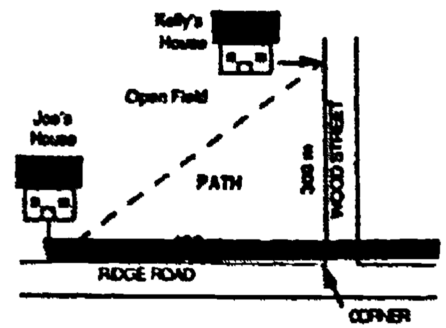
16 A) 450 m

56 B) 500 m

10 C) 550 m

10 D) 600 m

8 E) I don't know.



Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
8 A) 0 - 20%	13 A) It was done in a previous school year.
11 B) 21 - 40%	79 B) It was done during this school year.
27 C) 41 - 60%	5 C) It will be done later this year.
30 D) 61 - 80%	1 D) It will be done in a subsequent year.
24 E) 81 - 100%	1 E) It will not be done for reasons not listed here.

3.2 A 12. Joe, the window cleaner, uses a ladder that is 5 m long. When he places the foot of the ladder 2 m from the wall of the house, how high up the wall does the ladder reach?

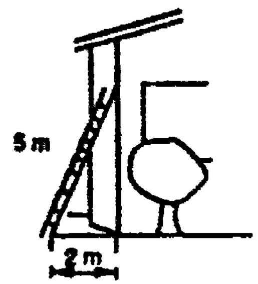
17 A) $\sqrt{10}$ m

15 B) $\sqrt{29}$ m

41 C) $\sqrt{21}$ m

12 D) 7 m

14 E) I don't know.



3.2 C 12. Δ ABC is a right triangle. Determine the length of side AC.

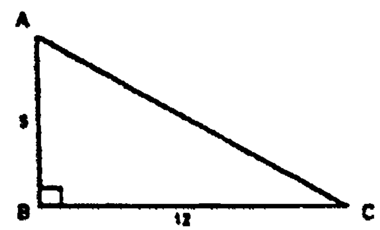
59 A) 13

22 B) 17

5 C) 49

6 D) 169

8 E) I don't know.



3.2 C 60. In the rectangular solid below, the length of the diagonal PS is

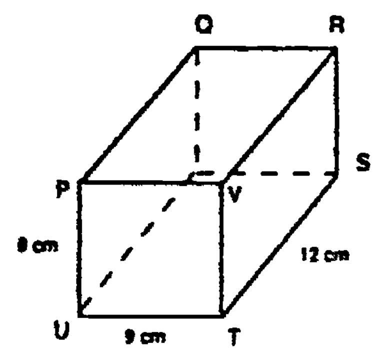
13 A) 21 cm

30 B) 17 cm

17 C) 20 cm

9 D) $\sqrt{200}$ cm

27 E) I don't know.



3.2 D 12. Δ RST and Δ RXY are right triangles. If RY = 4, XY = 3, and ST = 6, find RT.

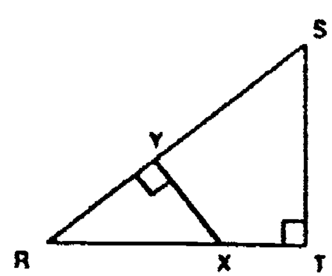
18 A) 7

35 B) 8

16 C) 10

7 D) 12

22 E) I don't know.



3.3 A 33. The coordinates of point P are

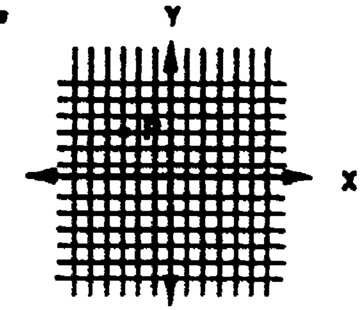
13 A) (−3, −3)

43 B) (−3, 3)

14 C) (3, −3)

14 D) (3, 3)

8 E) I don't know.



3.3 A 45. The graphs of the lines $y = -3$ and $x = 7$ intersect at which one of the following points?

62 A) (7, −3)

15 B) (−3, 7)

5 C) (−7, 3)

4 D) (3, −7)

9 E) I don't know.

3.3 A 46. Which one of the following statements about the graphs of $y = 2x - 5$ and $x + 2y = 8$ is true?

7 A) The graphs are parallel.

13 B) The graphs are coincident.

32 C) The graphs are perpendicular.

22 D) The graphs are not intersecting.

24 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.			Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.		
32	A)	0 - 20%	2	A)	It was done in a previous school year.
11	B)	21 - 40%	63	B)	It was done during this school year.
28	C)	41 - 60%	1	C)	It will be done later this year.
24	D)	61 - 80%	1	D)	It will be done in a subsequent year.
4	E)	81 - 100%	13	E)	It will not be done for reasons not listed here.

3.3 A 47. The slope of the line $3x = -2y - 7$ is

8 A) $\frac{2}{3}$

33 B) $-\frac{3}{2}$

28 C) $-\frac{2}{3}$

12 D) $\frac{3}{2}$

13 E) I don't know

3.3 B 33. The coordinates of point R are

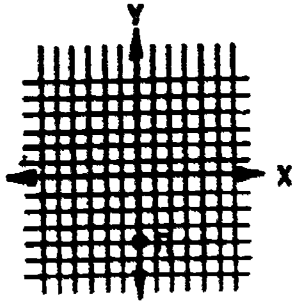
15 A) (– 4, 0)

50 B) (0, – 4)

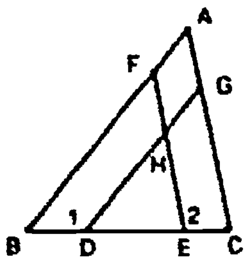
13 C) (0, 4)

9 D) (4, 0)

9 E) I don't know.



3.3 B 45. In the figure AB // DG and AC // FE. If ∠1 = 130° and ∠2 = 100°, find ∠ AGH.



12 A) 80°

10 B) 100°

55 C) 130°

9 D) 150°

13 E) I don't know.

3.3 B 46. Which one of the following points lies on the graph of 3x + 7y = 30?

4 A) (1, 2)

9 B) (2, 2)

14 C) (3, 2)

52 D) (3, 3)

20 E) I don't know.

3.3 B 47. If x > 0 and y < 0, then the point (x, y) is located in quadrant

15 A) I

18 B) II

15 C) III

32 D) IV

18 E) I don't know.

3.3 C 33 The coordinates of point O are

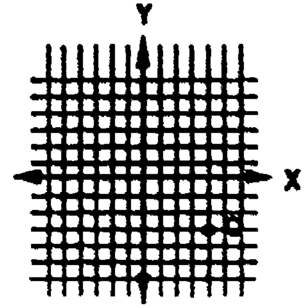
11 A) (– 4, 3)

17 B) (– 3, 4)

11 C) (3, – 4)

52 D) (4, – 3)

7 E) I don't know



3.3 C 45 If the lines $y = m_1x + b_1$, and $y = m_2x + b_2$ are parallel, then

16 A) $b_1 = b_2$

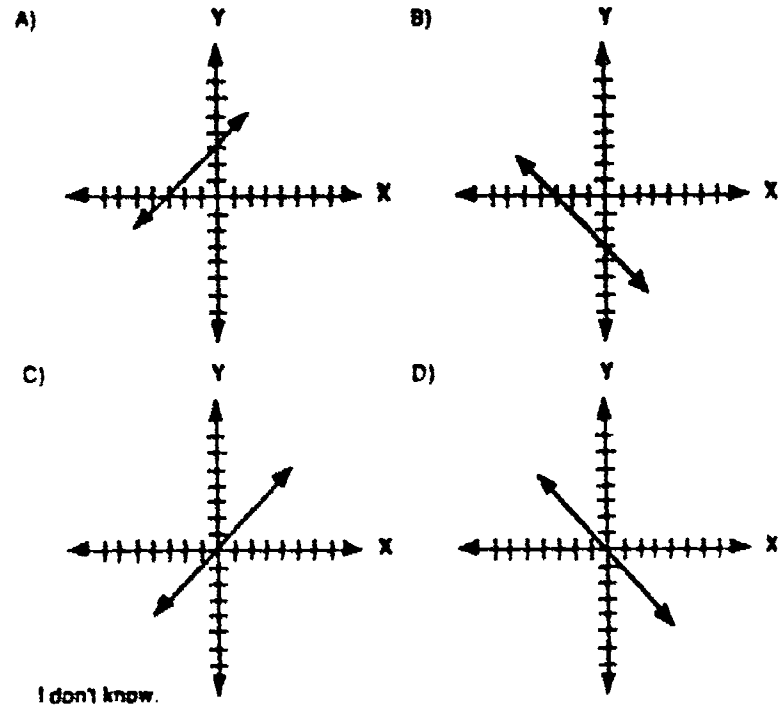
11 B) $y = x$

13 C) $m_1 = -\frac{1}{m_2}$

29 D) $m_1 = m_2$

30 E) I don't know.

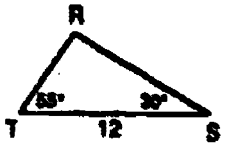
3.3 C 46. Which one of the following is the graph of x + y = – 3?

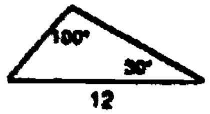


E) I don't know.

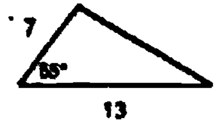
Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
9 A) 0 - 20%	3 A) It was done in a previous school year
10 B) 21 - 40%	87 B) It was done during this school year
26 C) 41 - 60%	4 C) It will be done later this year
32 D) 61 - 80%	3 D) It will be done in a subsequent year
23 E) 81 - 100%	3 E) It will not be done for reasons not listed here

3.4 A 49. Which triangle can you be sure is similar to Δ RST?

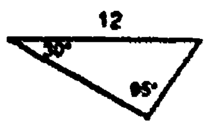


A) 

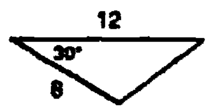
9

B) 

12

C) 

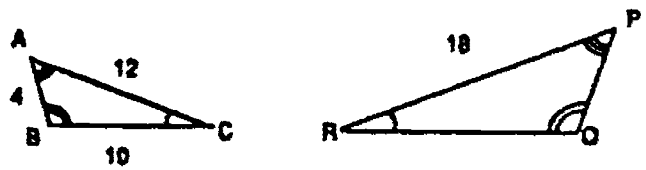
42

D) 

10

2 E) I don't know.

3.4 A 50. Δ ABC is similar to Δ PQR. How long is PQ?



14 A) 4

52 B) 6

13 C) 8

7 D) 9

8 E) I don't know.

3.4 B 34. Δ ABC is similar to Δ XYZ. Side x measures

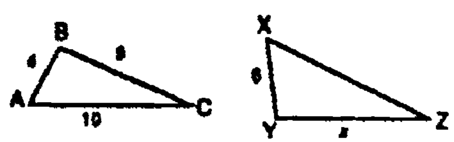
10 A) $6\frac{2}{3}$

18 B) $13\frac{1}{2}$

26 C) 15

14 D) 18

28 E) I don't know.



3.4 B 35. A map of a large ranch was drawn to a scale of 2 cm to 50 m. On the map the distance from the house to one of the barns was 13 cm. What was the actual distance between the house and the barn?

19 A) 650 m

16 B) 65 m

19 C) 1300 m

31 D) 325 m

11 E) I don't know.

3.4 B 48. Δ ABC is similar to Δ EFG. Δ ABC has sides of length 2, 6, and 7. The corresponding sides of Δ EFG are $\frac{1}{2}$, $\frac{3}{2}$, and x. The value of x is

8 A) $\frac{1}{2}$

42 B) $\frac{7}{4}$

16 C) $\frac{14}{4}$

10 D) $\frac{4}{7}$

23 E) I don't know.

3.4 B 49. If two triangles are similar, which one of the following must be true?

10 A) Their corresponding sides are different in length.

10 B) Their areas must be the same.

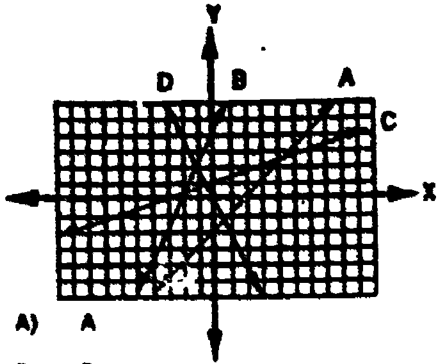
56 C) Their corresponding angles are congruent.

17 D) Their corresponding sides are congruent.

5 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
17 A) 0 - 20%	19 A) It was done in a previous school year.
17 B) 21 - 40%	51 B) It was done during this school year.
25 C) 41 - 60%	19 C) It will be done later this year.
23 D) 61 - 80%	3 D) It will be done in a subsequent year.
16 E) 81 - 100%	7 E) It will not be done for reasons not listed here

3.3 D 45. Which line is the graph of the equation $2x - y = -4$?



19 A) A

44 B) B

10 C) C

13 D) D

14 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
23 A) 0 - 20%	6 A) It was done in a previous school year.
19 B) 21 - 40%	73 B) It was done during this school year.
16 C) 41 - 60%	5 C) It will be done later this year.
32 D) 61 - 80%	6 D) It will be done in a subsequent year.
16 E) 81 - 100%	19 E) It will not be done for reasons not listed here

3.3 D 46. Which one of the following equations is satisfied by both of the ordered pairs $(3, -1)$ and $(10, -4)$?

11 A) $3x - 7y = 2$

12 B) $-3x + 7y = 2$

30 C) $y = \frac{-3}{7}x + \frac{2}{7}$

13 D) $y = \frac{-7}{3}x + \frac{2}{3}$

32 E) I don't know.

3.3 D 47. Quadrilateral ABDC is made up of 2 equilateral triangles ABC and BCD. The measure of $\angle ABD$ is

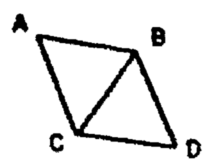
16 A) 60°

9 B) 90°

64 C) 120°

6 D) 150°

4 E) I don't know.



3.4 A 34. Δ ABC is a right triangle. If $\angle A = 40°$ and AB = 100 find AC.

sin 40° = 0.6428
cos 40° = 0.7660
tan 40° = 0.8391

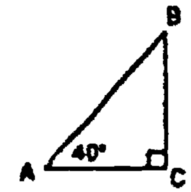
35 A) 64.28

12 B) 76.60

16 C) 83.91

12 D) 130.50

35 E) I don't know.



Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
31 A) 0 - 20%	2 A) It was done in a previous school year.
10 B) 21 - 40%	41 B) It was done during this school year.
10 C) 41 - 60%	40 C) It will be done later this year.
19 D) 61 - 80%	9 D) It will be done in a subsequent year.
12 E) 81 - 100%	7 E) It will not be done for reasons not listed here

3.4 A 35. A ladder 10 m long leans against a house and makes an angle of 60° with the ground. What approximate height above the ground does it rest against the house?

sin 60° = 0.8660
cos 60° = 0.5000
tan 60° = 1.7321

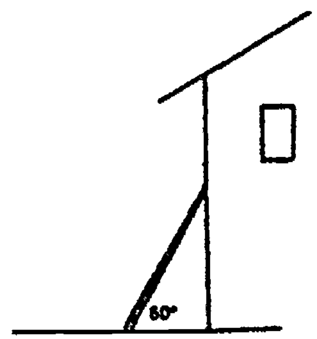
14 A) 5.0 m

29 B) 8.7 m

17 C) 17.3 m

10 D) 11.5 m

27 E) I don't know.



3.4 A 48. In the given diagram, $\frac{PW}{WR} = \frac{PS}{RQ} = \frac{3}{4}$. What is the value of the ratio $\frac{WQ}{SW}$?

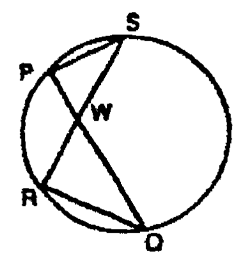
28 A) $\frac{3}{4}$

10 B) $\frac{7}{4}$

24 C) $\frac{4}{3}$

7 D) $\frac{3}{7}$

31 E) I don't know.



3.4 a 50. An ocean liner travels 10 km north and then 8 km east. How far is the ship from its starting point?

52 A) 11.7 km

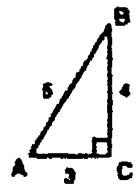
25 B) 16 km

11 C) 8 km

6 D) 4 km

5 E) I don't know.

3.4 c 34. The cosine of ∠ A in the figure is equal to



30 A) $\frac{3}{5}$

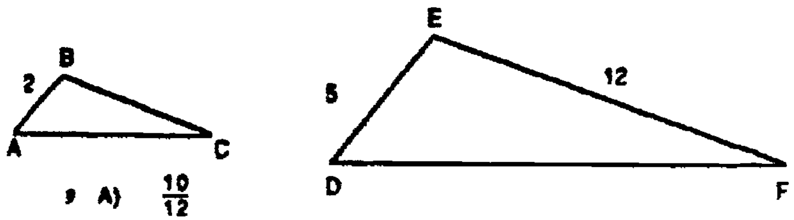
16 B) $\frac{3}{4}$

16 C) $\frac{4}{5}$

9 D) $\frac{5}{4}$

27 E) I don't know.

3.4 c 35. Δ ABC is similar to Δ DEF. Determine the length of side BC.



9 A) $\frac{10}{12}$

13 B) $\frac{24}{5}$

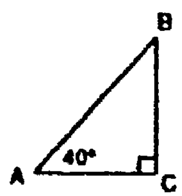
40 C) 5

13 D) 10

21 E) I don't know.

3.4 c 36. Δ ABC is a right triangle. If ∠ A = 40° and AC = 100, find AB.

sin 40° = 0.6428
cos 40° = 0.7660
tan 40° = 0.8391



13 A) 64.28

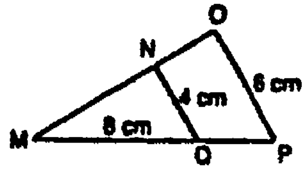
23 B) 76.60

21 C) 130.5

10 D) 155.6

33 E) I don't know

3.4 c 48. In the figure below, line NO is parallel to line OP, NO = 4 cm, OP = 6 cm, and MO = 8 cm. Find the length of MP.



17 A) 10 cm

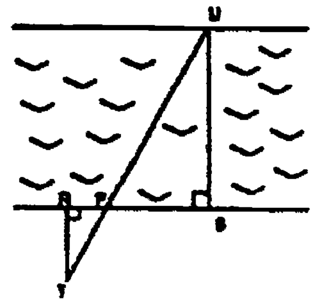
55 B) 12 cm

8 C) 14 cm

4 D) 16 cm

14 E) I don't know.

3.4 c 49. The figure below illustrates a water canal and a method of measuring its width. If PS = 24 m, PR = 2 m, and RT = 5 m, how wide is the canal?



5 A) 24 m

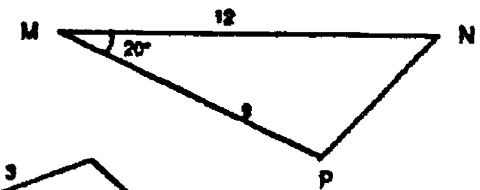
17 B) 32 m

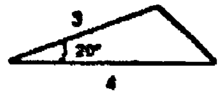
17 C) 40 m

38 D) 60 m

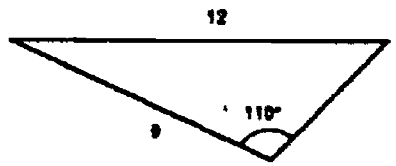
22 E) I don't know.

3.4 c 50. Which triangle can you be sure is similar to ΔMNP?

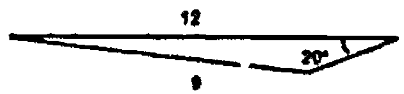




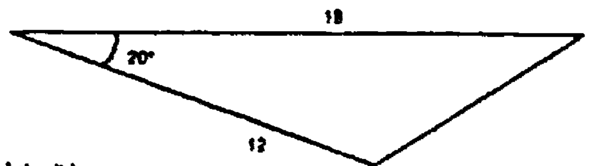
51 A)



20 B)



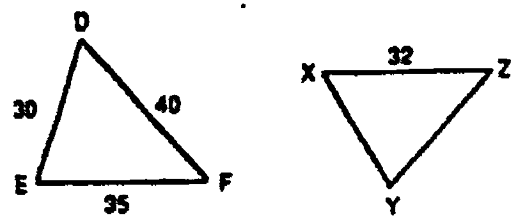
9 C)



13 D)

3 E) I don't know.

3.4 D 34. Δ DEF is similar to Δ XYZ. Find the length of YZ.



7 A) 26.25

28 B) 28

26 C) $37.\dot{3}$

11 D) 43.75

23 E) I don't know.

3.4 D 35. The tangent of ∠ A in the figure is equal to

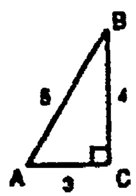
12 A) $\frac{4}{5}$

16 B) $\frac{5}{4}$

18 C) $\frac{3}{4}$

20 D) $\frac{4}{3}$

30 E) I don't know.



Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
30 A) 0 - 20%	9 A) It was done in a previous school year.
9 B) 21 - 40%	49 B) It was done during this school year.
12 C) 41 - 60%	19 C) It will be done later this year.
16 D) 61 - 80%	12 D) It will be done in a subsequent year
13 E) 81 - 100%	11 E) It will not be done for reasons not listed here

3.4 D 36. Δ ABC is a right triangle. If ∠ A = 40° and AC = 10, find BC.

sin 40° = 0.6428
cos 40° = 0.7660
tan 40° = 0.8391

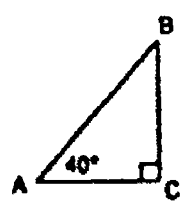
13 A) 11.917

18 B) 6.428

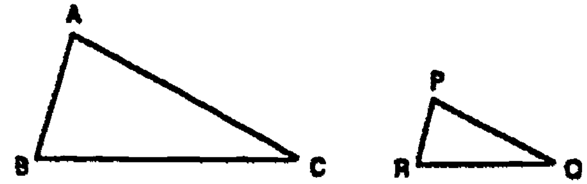
22 C) 8.391

10 D) 0.08391

34 E) I don't know.



3.4 D 48. If Δ ABC is similar to Δ PRQ, which one of the following is true?



3 A) $\frac{AB}{BC} = \frac{PQ}{QP}$

18 B) $\frac{AB}{PQ} = \frac{PR}{AC}$

8 C) $\frac{PR}{QR} = \frac{AC}{BC}$

60 D) $\frac{AB}{AC} = \frac{PR}{PQ}$

9 E) I don't know.

3.4 D 49. In the right triangle below ∠ C = 40° and BC = 20.0. Use the following information to find AB.

sin 40° = 0.6428
cos 40° = 0.7660
tan 40° = 0.8391

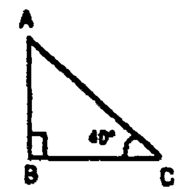
25 A) 16.8

11 B) 15.3

13 C) 12.9

11 D) 23.8

36 E) I don't know.



3.5 A 51. If Δ ABC is congruent to Δ DFE, then

6 A) AB = DE

55 B) ∠ BAC = ∠ FDE

5 C) AC = DF

24 D) ∠ ABC = ∠ DEF

9 E) I don't know.

3.5 A 52. In the figure below, if $\angle 1 + \angle 2 \neq 180°$, what can you conclude?

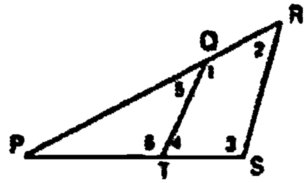
7 A) $\angle 5 = \angle 2$

42 B) QT is not parallel to RS.

13 C) $\angle 3 + \angle 4 = 180°$

12 D) $\angle 1 = \angle 6$

10 E) I don't know.



Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
26 A) 0 - 20%	16 A) It was done in a previous school year.
17 B) 21 - 40%	51 B) It was done during this school year.
23 C) 41 - 60%	17 C) It will be done later this year.
26 D) 61 - 80%	7 D) It will be done in a subsequent year.
9 E) 81 - 100%	9 E) It will not be done for reasons not listed here

3.5 B 51. The transversal T intersects line *m* and line *p*. Angle 2 and angle 5 are referred to as

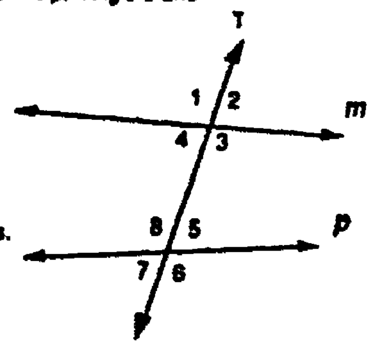
5 A) opposite angles.

11 B) vertical angles.

61 C) corresponding angles.

16 D) alternate interior angles.

5 E) I don't know.



3.5 B 52. ABCD is a rectangle. AB is congruent to BF, CD is congruent to DE, and AE is congruent to CF. Which one of the following must be true about ΔAED and ΔCFB?

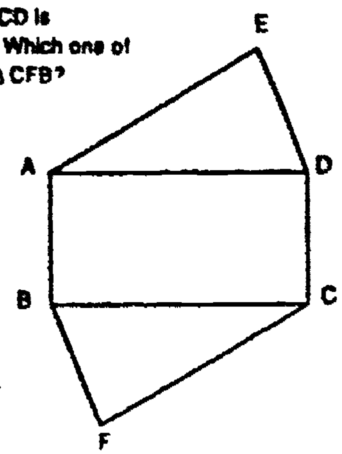
6 A) ΔAED is not congruent to ΔCFB

15 B) The data given are not enough to determine whether they are congruent.

54 C) ΔAED is congruent to ΔCFB (S-S-S)

15 D) ΔAED is congruent to ΔCFB (A-S-A).

7 E) I don't know.



Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
19 A) 0 - 20%	12 A) It was done in a previous school year.
19 B) 21 - 40%	56 B) It was done during this school year.
29 C) 41 - 60%	19 C) It will be done later this year.
22 D) 61 - 80%	4 D) It will be done in a subsequent year.
11 E) 81 - 100%	9 E) It will not be done for reasons not listed here.

3.5 C 51. In triangle ABC, BD is the median to AC. What additional information is required to show that triangle ABD is congruent to triangle CBD?

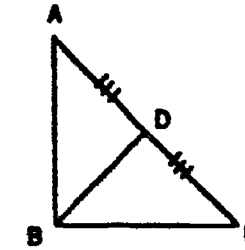
6 A) AB = CD

75 B) AB = BC

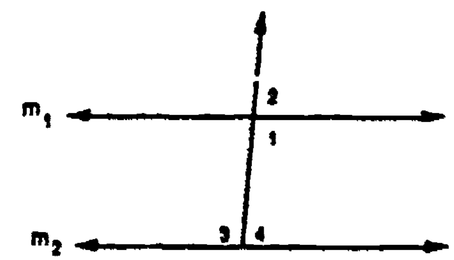
6 C) BD = AB

4 D) AC = BC

7 E) I don't know.



3.5 C 52. In order for m_1 to be parallel to m_2, which one of the following must be true?



5 A) $\angle 3$ and $\angle 4$ must both be right angles.

12 B) $\angle 1$ must have the same measure as $\angle 4$.

58 C) $\angle 1 + \angle 4$ must equal 180°.

16 D) $\angle 3$ must have the same measure as $\angle 2$.

6 E) I don't know.

3.5 D 51. In triangle PQR, ST will be parallel to RQ if

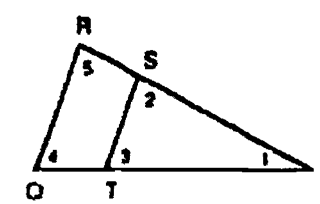
9 A) $\angle 1 + \angle 2 + \angle 3 = 180°$

12 B) $\angle 2 + \angle 5 = 180°$

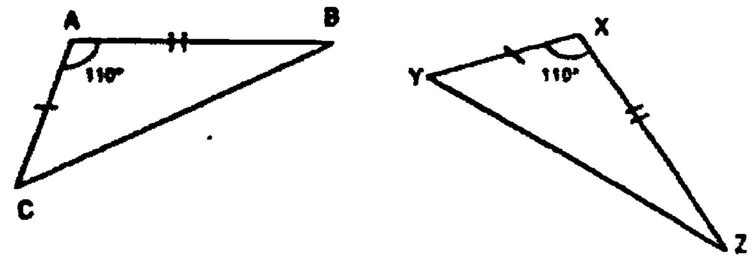
56 C) $\angle 3 = \angle 4$

11 D) $\angle 4 = \angle 2$

8 E) I don't know



3.5 D 52. In the figures below AB = XZ, AC = XY, and ∠ CAB and ∠ YXZ each measure 110°. Are the triangles congruent? If so, choose the answer that tells you this.



5 A) Yes (S-S-S)

9 B) Yes (A-S-A)

6 C) No

20 D) Yes (S-A-S)

7 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
21 A) 0 - 20%	17 A) It was done in a previous school year.
19 B) 21 - 40%	52 B) It was done during this school year.
12 C) 41 - 60%	17 C) It will be done later this year.
19 D) 61 - 80%	7 D) It will be done in a subsequent year.
36 E) 81 - 100%	7 E) It will not be done for reasons not listed here

4.1 A 13. The perimeter of an isosceles triangle is 21 cm and the length of one of its equal sides is 9 cm. What is the length of the shortest side?

9 A) 6 cm

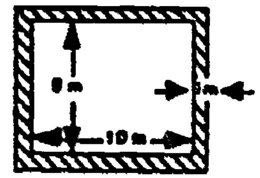
5 B) 1.5 cm

6 C) 4.5 cm

11 D) 3 cm

8 E) I don't know.

4.1 B 13. A rectangular pool is to be surrounded by a rectangular cement walk 1 m wide. If cement costs $2.50 per square metre and the dimensions of the pool are 10 m by 8 m, what would the walk cost?



12 A) $ 40

16 B) $ 80

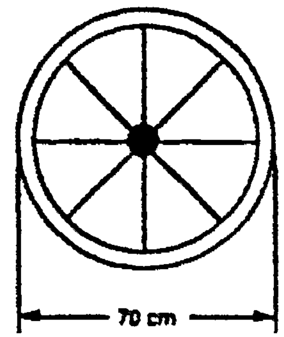
42 C) $100

15 D) $120

15 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
17 A) 0 - 20%	38 A) It was done in a previous school year.
29 B) 21 - 40%	54 B) It was done during this school year.
27 C) 41 - 60%	6 C) It will be done later this year.
21 D) 61 - 80%	4 D) It will be done in a subsequent year.
6 E) 81 - 100%	4 E) It will not be done for reasons not listed here.

4.1 B 36. The diameter of a tricycle wheel is 70 cm. Approximately how far forward does the tricycle travel for one complete turn of its wheel?



15 A) 70 cm

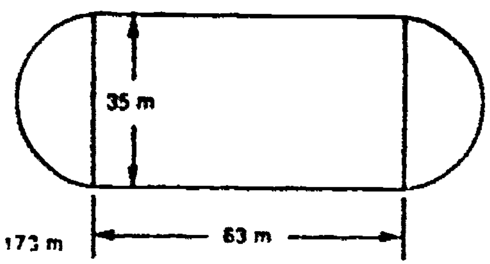
44 B) 140 cm

22 C) 220 cm

8 D) 3850 cm

8 E) I don't know.

4.1 B 37. The field illustrated below is laid out as a rectangle, with a semi-circle at each end. Approximately how far is it around the outside edge of the field?



17 A) 173 m

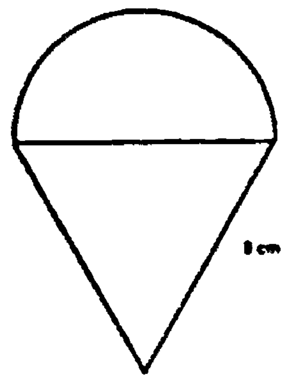
19 B) 181 m

30 C) 236 m

14 D) 346 m

21 E) I don't know

4.1 C 13. Find the perimeter of the figure below which consists of an equilateral triangle and a semi-circle.
(Use $\pi = 3.14$)



19 A) 41.1 cm

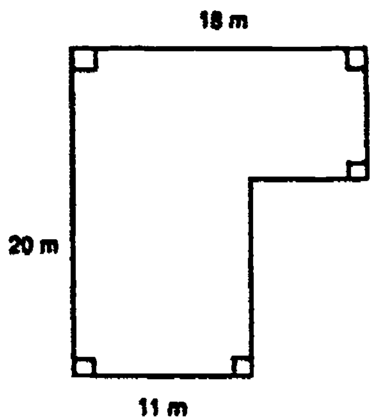
11 B) 33.1 cm

34 C) 28.6 cm

7 D) 20.6 cm

28 E) I don't know.

4.1 C 37. Determine the perimeter of this figure.



18 A) 49 m

14 B) 58 m

43 C) 76 m

10 D) 87 m

8 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
3 A) 0 - 20%	44 A) It was done in a previous school year.
6 B) 21 - 40%	47 B) It was done during this school year.
21 C) 41 - 60%	2 C) It will be done later this year.
37 D) 61 - 80%	1 D) It will be done in a subsequent year.
33 E) 81 - 100%	2 E) It will not be done for reasons not listed here

4.2 A 15. How many one centimetre squares would be required to cover the entire surface of a rectangular block that measures 3 cm by 5 cm by 7 cm.
Surface Area = $2(lw + lh + wh)$

11 A) 31

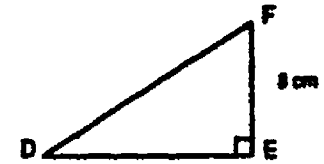
10 B) 71

26 C) 105

32 D) 142

15 E) I don't know.

4.2 A 37. If the area of Δ DEF is 42 cm^2, determine the length of side DE.



15 A) 5.25 cm

28 B) 10.5 cm

25 C) 12 cm

19 D) 21 cm

19 E) I don't know.

4.2 B 15. A litre of asphalt paint will cover about 6 m^2 of surface. The paint is sold in cans of five litres only. How many cans are needed to paint a driveway 15 m long and 3 m wide?

36 A) 2

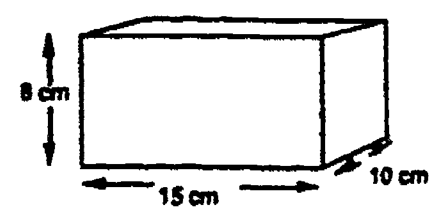
14 B) 7

26 C) 8

13 D) 9

10 E) I don't know.

4.2 B 38. The surface area of this rectangular prism is



13 A) 350 cm^2

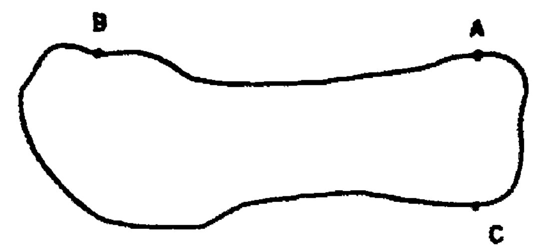
9 B) 500 cm^2

18 C) 700 cm^2

41 D) 1200 cm^2

12 E) I don't know.

4.2 C 15. Towns A, B, and C are on the shore of a lake as shown in the map below. The distance from A to B is 7.8 km and the distance from A to C is 2.4 km. Which one of the following is the best estimate for the area of the lake?



17 A) 10 km^2

46 B) 18 km^2

9 C) 14 km^2

21 D) 24 km^2

7 E) I don't know.

4.2 C 16. In the diagram below, the area of rectangle PQRS is 24 cm^2. What is the area of the parallelogram QVRS?

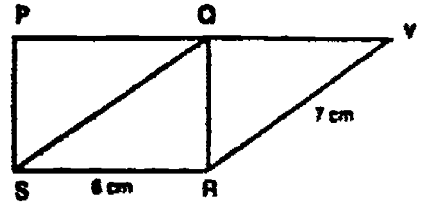
14 A) 48 cm^2

17 B) 36 cm^2

43 C) 24 cm^2

8 D) 18 cm^2

17 E) I don't know.



4.2 C 38. What is the approximate total surface area of the solid cylinder below? Use the formula
Surface Area = $2\pi r^2 + 2\pi rh$.

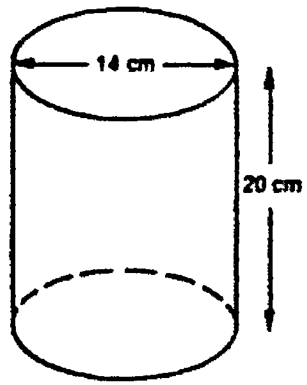
13 A) 880 cm^2

30 B) 1187 cm^2

18 C) 308 cm^2

13 D) 934 cm^2

22 E) I don't know.



4.2 D 13. The best estimate for the area of the circle shown below is

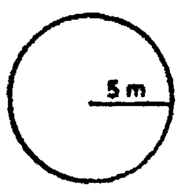
20 A) 15 m^2

44 B) 75 m^2

9 C) 100 m^2

17 D) 5 m^2

10 E) I don't know.



Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
7 A) 0 - 20%	48 A) It was done in a previous school year
13 B) 21 - 40%	41 B) It was done during this school year.
31 C) 41 - 60%	8 C) It will be done later this year.
35 D) 61 - 80%	8 D) It will be done in a subsequent year.
14 E) 81 - 100%	2 E) It will not be done for reasons not listed here

4.2 D 14. Find the surface area of the square pyramid shown below. Surface Area = $b^2 + 4(\frac{1}{2}bh)$, where b is the length of the base and h is the slant height.

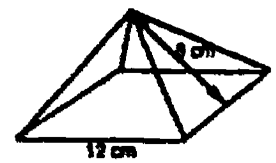
11 A) 192 cm^2

8 B) 144 cm^2

56 C) 336 cm^2

8 D) 384 cm^2

17 E) I don't know.



4.2 D 15. What is the surface area of the rectangular prism shown below?
Surface Area = $2(lw + lh + wh)$

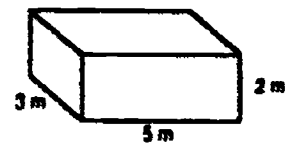
11 A) 30 m^2

10 B) 31 m^2

10 C) 60 m^2

61 D) 62 m^2

8 E) I don't know.



4.2 D 37. The area of this figure is

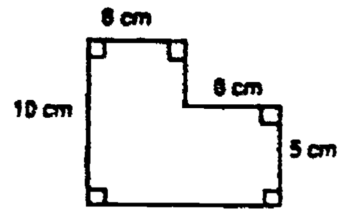
29 A) 39 cm^2

21 B) 44 cm^2

23 C) 90 cm^2

15 D) 120 cm^2

10 E) I don't know.



4.3 A 38. The volume of a pyramid is equal to $\frac{1}{3}$ Bh, where B is the area of the base and h is the vertical heig' The volume of the pyramid shown below is

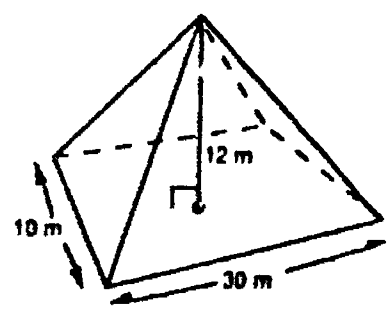
21 A) 1200 m^3

15 B) 1800 m^3

15 C) 2400 m^3

25 D) 3600 m^3

20 E) I don't know.



4.3 B 15. A small cube measures 2 cm by 2 cm by 2 cm. How many of these can be put into a rectangular box that is 24 cm long, 10 cm wide, and 6 cm deep?

11 A) 60

58 B) 180

12 C) 720

7 D) 1440

11 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
19 A) 0 - 20%	41 A) It was done in a previous school year.
29 B) 21 - 40%	36 B) It was done during this school year.
29 C) 41 - 60%	12 C) It will be done later this year.
17 D) 61 - 80%	2 D) It will be done in a subsequent year.
3 E) 81 - 100%	10 E) It will not be done for reasons not listed here.

4.3 D 16. The best estimate for the volume of the solid shown below is

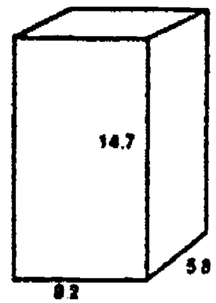
12 A) 29

9 B) 56

19 C) 350

44 D) 720

15 E) I don't know.



4.3 D 38. The volume of the rectangular prism below is 576 cm^3. What is its height?

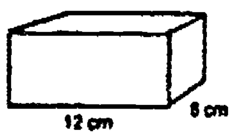
12 A) 4 cm

46 B) 8 cm

12 C) 16 cm

14 D) 32 cm

14 E) I don't know.



Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
14 A) 0 - 20%	40 A) It was done in a previous school year.
21 B) 21 - 40%	43 B) It was done during this school year.
30 C) 41 - 60%	12 C) It will be done later this year
26 D) 61 - 80%	2 D) It will be done in a subsequent year.
9 E) 81 - 100%	3 E) It will not be done for reasons not listed here

5.1 A 16. Simplify: $7x - 2y - 2x - 4y$

7 A) $-5x - 6y$

81 B) $5x - 6y$

3 C) $6y - 5x$

4 D) $14x - 6y$

4 E) I don't know.

5.1 A 17. Simplify: $r + s - (r - s)$

22 A) 0

20 B) $2r + 2s$

6 C) $2r$

45 D) $2s$

7 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
6 A) 0 - 20%	11 A) It was done in a previous school year.
9 B) 21 - 40%	85 B) It was done during this school year.
25 C) 41 - 60%	1 C) It will be done later this year.
35 D) 61 - 80%	1 D) It will be done in a subsequent year.
24 E) 81 - 100%	1 E) It will not be done for reasons not listed here

5.1 A 18. Write an expression for the square of three times a number.

30 A) $3x^2$

5 B) $2(3x)$

5 C) $3(2x)$

55 D) $(3x)^2$

4 E) I don't know.

5.1 A 40. The cost of a new car is less than 4 times the cost of a used car. If x represents the cost of a new car, and y represents the cost of a used car, which one of these is true?

31 A) $x < 4y$

13 B) $x - y = 4$

20 C) $y > 4x$

14 D) $x = y + 4$

17 E) I don't know.

5.1 A 53. Find the missing factor. $42a^2bc^5 = (2bc^2)(\quad)$

42 A) $21a^2c^3$

12 B) $21a^2bc^3$

8 C) $40a^2c^3$

4 D) $40a^2bc^3$

8 E) I don't know.

5.1 A 54. The greatest common factor of $5x^2y^3$, $15xy^2$, and $20x^2y^2$ is

11 A) $5xy$

74 B) $5xy^2$

4 C) $20x^2y^3$

6 D) $60x^2y^3$

3 E) I don't know.

5.1 A 55. Simplify: $12y^4z^6 \div 4yz^3$

76 A) $3y^3z^3$

11 B) $3y^4z^2$

6 C) $3y^4z^3$

3 D) $8y^3z^3$

3 E) I don't know.

5.1 A 58. Factor completely: $12 - 23x + 5x^2$

50 A) $(3-5x)(4-x)$

14 B) $(4+x)(3-5x)$

9 C) $(6-x)(2-4x)$

8 D) $(12+3x)(1-2x)$

16 E) I don't know.

5.1 B 18. Evaluate: $3a^2 - 2b$ when $a = -0.5$ and $b = 0.2$

9 A) 7.1

12 B) 1.15

10 C) -1.15

56 D) 0.35

12 E) I don't know.

5.1 B 39. Evaluate: $-4a(a-3b)$ when $a = 2$ and $b = -1$

23 A) -40

22 B) -8

21 C) 8

12 D) 40

17 E) I don't know.

5.1 B 40. When $m = -1$ and $n = 1$, the value of $\frac{m^{20}}{n}$ is

14 A) -1

21 B) 1

25 C) -20

14 D) 20

19 E) I don't know.

5.1 B 53. A right triangle has a hypotenuse of length x and legs of lengths y and z. What is its area?

7 A) $\frac{1}{2}x^2y$

9 B) xz^2

16 C) $\frac{1}{2}xy$

32 D) $\frac{1}{2}yz$

27 E) I don't know.

5.1 B 54. Expand: $(3x+4y^2)^2$

8 A) $6x^2 + 8y^4$

44 B) $9x^2 + 16y^4$

9 C) $9x^2 + 12xy^2 + 16y^4$

31 D) $9x^2 + 24xy^2 + 16y^4$

4 E) I don't know.

5.1 B 55. Expand and simplify: $(2x-5)^2-3(x-7)$

13 A) $4x^2-3x-32$

15 B) $4x^2-23x+4$

26 C) $4x^2-23x+46$

13 D) $4x^2-3x+18$

17 E) I don't know.

5.1 B 56. Find the missing factor: $4(\quad)-3(x+y)=x+y$

11 A) $-x-y$

10 B) $-x+y$

16 C) $x-y$

44 D) $x+y$

14 E) I don't know.

5.1 C 18. Evaluate: $2-(2-x)$ when $x=-1$

21 A) 1

61 B) -1

6 C) 2

8 D) -2

4 E) I don't know.

5.1 C 39. If $x=4$, $y=2$, and $z=0.5$, the value of $2xy^2z$ is

42 A) 16

12 B) 32

14 C) 64

12 D) 128

11 E) I don't know.

5.1 C 53. Expand: $(a-7)(a-2)$

9 A) $a^2-5a+14$

11 B) $a^2-9a-14$

70 C) $a^2-9a+14$

4 D) $a^2-14a-9$

4 E) I don't know.

5.1 C 54. Factor completely over the rational numbers: $4a^2-8$

25 A) $(2a+4)(2a-2)$

26 B) $2(2a+2)(a-2)$

25 C) $2^2(a^2-2)$

11 D) $2^2(a+2)(a-1)$

10 E) I don't know.

5.1 C 55. Factor completely: a^2-36b^2

7 A) $(a-12b)(a+3b)$

10 B) $(a-6b)(a-6b)$

69 C) $(a-6b)(a+6b)$

5 D) $(a-4b)(a+9b)$

5 E) I don't know.

5.1 C 56. $A=3n^2-2n+5$. If $n=-2$, then the value of A is

6 A) -5

9 B) 10

10 C) 15

61 D) 21

11 E) I don't know.

5.1 D 18. Simplify: $(3p+2q)-(p+q)$

57 A) $2p+q$

17 B) $2p+3q$

13 C) $4p-3q$

6 D) $4p-q$

7 E) I don't know.

5.1 D 53 Simplify: $15p^6 \div 3p^2$

15 A) $5p^3$

22 B) $5p^4$

3 C) $12p^3$

4 D) $12p^4$

4 E) I don't know.

5.1 D 54. If $\sqrt{a} = 0.9x^4$, then a =

22 A) $0.3x^2$

13 B) $0.81x^2$

6 C) $0.32x^8$

48 D) $0.81x^8$

16 E) I don't know.

5.1 D 55. Simplify: $\sqrt{\frac{0.0049x^8}{y^6}}$

4 A) $0.7x^4y^3$

9 B) $0.07x^4y^3$

32 C) $\frac{0.07x^4}{y^3}$

21 D) $\frac{0.007x^4}{y^3}$

25 E) I don't know.

5.1 D 56. $R = \frac{1}{x} + \frac{1}{y}$. If $x = 2$ and $y = 3$, then the value of R is

6 A) $\frac{1}{6}$

9 B) $\frac{1}{5}$

7 C) $\frac{2}{5}$

71 D) $\frac{5}{6}$

3 E) I don't know.

5.2 A 19. Solve: $2 - (1 - y) = 2 - y$

12 A) $y = 0$

10 B) $y = -0.5$

38 C) $y = 0.5$

26 D) $y = 1$

14 E) I don't know.

5.2 A 57. Solve for x when $x \neq 0$: $\frac{1}{x} + \frac{3}{x} = \frac{1}{5}$

4 A) -20

8 B) -15

16 C) 15

48 D) 20

21 E) I don't know.

5.2 A 58. Solve for x. $x - 3 \geq 7$

17 A) $x \leq 10$

11 B) $x \leq 4$

55 C) $x \geq 10$

8 D) $x > 10$

7 E) I don't know.

5.2 A 59. Solve for x. $3x + 7 = 5x + 4$

4 A) $x = -\frac{11}{2}$

15 B) $x = -\frac{3}{2}$

61 C) $x = \frac{3}{2}$

6 D) $x = \frac{11}{2}$

9 E) I don't know.

5.2 A 60. If $x = \frac{3y + 2}{4}$, then y =

9 A) $\frac{4x}{3} - 2$

37 B) $\frac{4x - 2}{3}$

18 C) $\frac{4x + 2}{3}$

10 D) $4x - \frac{2}{3}$

23 E) I don't know

5.2 B 19. Solve: $4.5 - 5x = 10x - 1.5$

9 A) $x = 0.2$

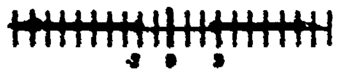
54 B) $x = 0.4$

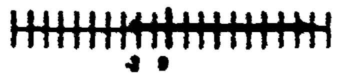
14 C) $x = 0.6$

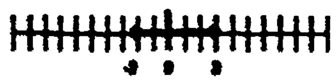
8 D) $x = 0.8$

15 E) I don't know.

5.2 B 57. The graph of $x \geq -2$ and $x \leq 3$ is

A) 

B) 

C) 

D) 

E) I don't know.

5.2 B 58 Solve: $2x^2 = 1 - x$

18 A) $x = \frac{1}{2}$ or $x = -1$

21 B) $x = \frac{1}{2}$

14 C) $x = -1$

15 D) $x = -\frac{1}{2}$ or $x = 1$

25 E) I don't know

5.2 B 59. Solve the following equation for t: $Ax + Bt = C$

9 A) $t = C - Ax - B$

36 B) $t = \frac{C - Ax}{B}$

12 C) $t = \frac{C}{B} - Ax$

5 D) $t = C - A - B$

32 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
14 A) 0-20%	3 A) It was done in a previous school year.
17 B) 21-40%	85 B) It was done during this school year.
32 C) 41-60%	1 C) It will be done later this year.
29 D) 61-80%	3 D) It will be done in a subsequent year.
9 E) 81-100%	7 E) It will not be done for reasons not listed here.

5.2 B 60. Solve for n: $4(n - 3) - 5 = 7n$

43 A) $n = \frac{-17}{3}$

13 B) $n = \frac{17}{3}$

12 C) $n = \frac{7}{3}$

9 D) $n = \frac{-7}{3}$

33 E) I don't know.

5.2 C 19 Solve: $5.3x - 12 = 2.4x + 46$

7 A) $x = 2$

52 B) $x = 20$

11 C) $x = \frac{340}{29}$

6 D) $x = \frac{340}{77}$

18 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
9 A) 0-20%	33 A) It was done in a previous school year
14 B) 21-40%	42 B) It was done during this school year
27 C) 41-60%	3 C) It will be done later this year.
32 D) 61-80%	3 D) It will be done in a subsequent year
17 E) 81-100%	3 E) It will not be done for reasons not listed here

5.2 C 40. Solve for x: $3x + 7 = 5x + 4$

9 A) $x = -\frac{11}{2}$

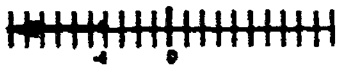
19 B) $x = -\frac{3}{2}$

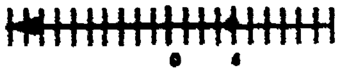
28 C) $x = \frac{3}{4}$

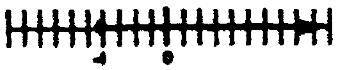
13 D) $x = \frac{11}{2}$

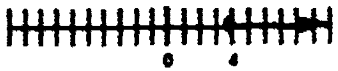
28 E) I don't know.

5.2 C 57. Which one of the following is the graph of $2x - 3 \geq 5$?

A) 

B) 

C) 

D) 

E) I don't know.

5.2 C 58. Which one of the following statements about the equation $2(x - 7) = 2x + 5$ is true?

44 A) The equation has no solution.

14 B) The equation has infinitely many solutions.

12 C) $x = 0$

15 D) $x = 19$

10 E) I don't know.

5.2 C 59. Find the value of x such that: $5x^2 + 15 = 95$

41 A) 4

7 B) -4

28 C) ± 4

9 D) All real numbers

10 E) I don't know.

5.2 D 19. If five is added to a certain number and the sum is multiplied by three, the result is -17. Find the number.

16 A) $-\frac{2}{3}$

11 B) -4

15 C) $-7\frac{1}{3}$

33 D) $-10\frac{2}{3}$

24 E) I don't know.

5.2 D 40. Solve for n: $4(n - 3) - 5 = 7n$

14 A) $n = -\frac{17}{3}$

14 B) $n = \frac{17}{3}$

22 C) $n = \frac{7}{3}$

13 D) $n = -\frac{7}{3}$

32 E) I don't know.

5.2 D 57. Solve for x: $5x - 15x + 8 \leq 18$

14 A) $x \leq 1$

16 B) $x \geq 1$

25 C) $x \leq -1$

25 D) $x \geq -1$

15 E) I don't know.

5.2 D 58 Solve for x: $x + 3 = \frac{1}{2}x - 1$

32 A) $x = -8$

14 B) $x = -\frac{8}{3}$

19 C) $x = 4$

10 D) $x = 8$

15 E) I don't know.

5.2 D 59. Solve the following equation for m: $y = mx + b$

8 A) $m = y - b - x$

50 B) $m = \frac{y - b}{x}$

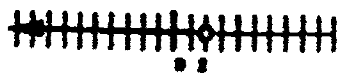
11 C) $m = y + b - x$

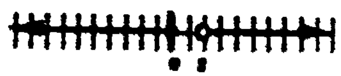
13 D) $m = \frac{1}{x}(b - y)$

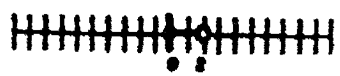
13 E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
20 A) 0 - 20%	5 A) It was done in a previous school year
13 B) 21 - 40%	76 B) It was done during this school year
29 C) 41 - 60%	4 C) It will be done later this year
27 D) 61 - 80%	6 D) It will be done in a subsequent year.
11 E) 81 - 100%	9 E) It will not be done for reasons not listed here

5.2 D 60. The graph of $x \leq 0$ or $x > 2$ is

A) 

B) 

C) 

D) 

E) I don't know.

Estimate what percentage of the students in your class will get this item correct other than by chance.	Indicate whether you taught or reviewed the mathematics needed to answer the item correctly? Mark only one.
13 A) 0 - 20%	22 A) It was done in a previous school year
18 B) 21 - 40%	53 B) It was done during this school year
28 C) 41 - 60%	3 C) It will be done later this year.
30 D) 61 - 80%	12 D) It will be done in a subsequent year
11 E) 81 - 100%	9 E) It will not be done for reasons not listed here

NS A 20. About how many is a million?

29 A) The number of hairs on your head.

9 B) The number of grains of sand on a beach.

15 C) The number of people that could be packed onto a soccer field standing up.

34 D) The number of tennis balls needed to fill a classroom.

12 E) I don't know.

NS B 20. About how much does a horse weigh?

2 A) 4 kg

5 B) 40 kg

61 C) 400 kg

17 D) 4000 kg

15 E) I don't know.

NS C 20. If you divide any positive number by a number greater than 2, then the answer will be

47 A) less than half the original number.

12 B) more than half the original number.

9 C) a fraction.

24 D) impossible to predict.

7 E) I don't know.

NS D 20. How high would a stack of one million pennies be?

11 A) 2 m

17 B) 200 m

25 C) 2 000 m

16 D) 20 000 m

30 E) I don't know

APPENDIX H

Student Background Questionnaires

GRADE 4 STUDENT BACKGROUND INFORMATION

For each item, shade the appropriate space on the answer sheet

1. Sex

52 A) Male
48 B) Female

2. Age

1 A) 8 or less
51 B) 9
44 C) 10
4 D) 11
0 E) 12 or more

3. What program are you in?

92 A) Regular Grade 4 program in English
7 B) Early French immersion
1 C) Programme-cadre de français

4. In this class, mathematics is taught in

98 A) English.
2 B) French.

For the next three items, decide whether you agree or disagree

5. You have to be able to do mathematics to get a good job when you grow up.

2 A) Strongly disagree
4 B) Disagree
10 C) Do not know
45 D) Agree
40 E) Strongly agree

6. Most people use mathematics in their jobs.

2 A) Strongly disagree
5 B) Disagree
12 C) Do not know
54 D) Agree
28 E) Strongly agree

7. When I leave school, I would like a job where I have to use mathematics.

5 A) Strongly disagree
12 B) Disagree
28 C) Do not know
36 D) Agree
19 E) Strongly agree

For each of the next four items, three answers are needed.

A) Tell how important you think the topic is.
B) Tell how easy you think the topic is.
C) Tell how much you like the topic.

If you are not sure what a topic means, leave its answers blank

8. Adding, subtracting, multiplying, and dividing whole numbers

	A		B		C
1	not at all important	2	very difficult	4	dislike a lot
1	not important	14	difficult	8	dislike
6	undecided	17	undecided	10	undecided
45	important	51	easy	49	like
47	very important	16	very easy	29	like a lot

9. Learning about decimals

	A		B		C
1	not at all important	2	very difficult	3	dislike a lot
3	not important	13	difficult	10	dislike
12	undecided	18	undecided	17	undecided
49	important	43	easy	47	like
35	very important	24	very easy	24	like a lot

10. Learning about fractions

	A		B		C
1	not at all important	2	very difficult	3	dislike a lot
3	not important	12	difficult	9	dislike
11	undecided	15	undecided	15	undecided
52	important	43	easy	44	like
33	very important	27	very easy	29	like a lot

11. Learning how to estimate

	A		B		C
2	not at all important	2	very difficult	4	dislike a lot
5	not important	12	difficult	11	dislike
12	undecided	12	undecided	13	undecided
49	important	41	easy	44	like
32	very important	32	very easy	29	like a lot

8. Learning things about geometry like shapes, flips, turns, and slides

	A		B		C
3	not at all important	2	very difficult	3	dislike a lot
6	not important	14	difficult	10	dislike
14	undecided	17	undecided	13	undecided
53	important	50	easy	51	like
24	very important	17	very easy	23	like a lot

9. Checking answers

	A		B		C
1	not at all important	1	very difficult	3	dislike a lot
3	not important	8	difficult	12	dislike
6	undecided	10	undecided	14	undecided
40	important	48	easy	49	like
49	very important	33	very easy	22	like a lot

10 Using graphs

	A		B		C
2	not at all important	3	very difficult	3	dislike a lot
4	not important	16	difficult	12	dislike
18	undecided	18	undecided	17	undecided
51	important	44	easy	44	like
24	very important	19	very easy	23	like a lot

11. Learning about place value

	A		B		C
2	not at all important	3	very difficult	4	dislike a lot
3	not important	17	difficult	13	dislike
13	undecided	22	undecided	21	undecided
45	important	41	easy	44	like
37	very important	19	very easy	18	like a lot

8. Learning about measuring weight, height, length, and width

	A		B		C
2	not at all important	2	very difficult	3	dislike a lot
4	not important	16	difficult	12	dislike
10	undecided	17	undecided	14	undecided
55	important	52	easy	33	like
29	very important	14	very easy	19	like a lot

9. Learning how to use calculators

	A		B		C
4	not at all important	1	very difficult	2	dislike a lot
8	not important	4	difficult	5	dislike
10	undecided	6	undecided	8	undecided
50	important	42	easy	44	like
29	very important	48	very easy	42	like a lot

10. Using objects such as blocks, counters, and geoboards

	A		B		C
6	not at all important	1	very difficult	5	dislike a lot
14	not important	8	difficult	16	dislike
24	undecided	15	undecided	18	undecided
43	important	44	easy	43	like
13	very important	32	very easy	18	like a lot

11. Learning strategies for problem solving, such as looking for patterns and making models

	A		B		C
2	not at all important	4	very difficult	4	dislike a lot
4	not important	24	difficult	12	dislike
14	undecided	19	undecided	16	undecided
46	important	41	easy	44	like
33	very important	12	very easy	24	like a lot

12. The teacher shows us what to do on the blackboard or the overhead projector.

49 A) Almost every day
22 B) Often
19 C) Sometimes
8 D) Rarely
3 E) Never

13. We use objects like blocks, counters, and geoboards.

3 A) Almost every day
10 B) Often
30 C) Sometimes
35 D) Rarely
23 E) Never

14. We work individually on problems or other exercises the teacher assigns.

43 A) Almost every day
26 B) Often
22 C) Sometimes
7 D) Rarely
2 E) Never

12. We use calculators.

4 A) Almost every day
8 B) Often
30 C) Sometimes
36 D) Rarely
23 E) Never

13. We have quizzes or tests.

7 A) Almost every day
35 B) Often
44 C) Sometimes
12 D) Rarely
2 E) Never

14. We review our homework and discuss the solutions

36 A) Almost every day
25 B) Often
21 C) Sometimes
12 D) Rarely
6 E) Never

12. We work in small groups

15 A) Almost every day
19 B) Often
39 C) Sometimes
21 D) Rarely
6 E) Never

13. We use computers

10 A) Almost every day
25 B) Often
28 C) Sometimes
18 D) Rarely
19 E) Never

14 The teacher helps individual students

45 A) Almost every day
25 B) Often
22 C) Sometimes
7 D) Rarely
2 E) Never

GRADE 7 STUDENT BACKGROUND INFORMATION

For each item, shade in the appropriate space on the answer sheet.

1. Sex

52 A) Male
48 B) Female

2. Age

0 A) 10 or less
1 B) 11
50 C) 12
45 D) 13
5 E) 14 or more

3. What program are you in?

93 A) Regular Grade 7 program in English
4 B) Early French Immersion
3 C) Late French Immersion
1 D) Programme-cadre de français

4. In this class, mathematics is taught in

99 A) English.
1 B) French.

For the next three items, decide to what extent you agree or disagree

5. You have to be able to do mathematics to get a good job when you grow up.

1 A) Strongly Disagree
4 B) Disagree
6 C) Do not know
53 D) Agree
37 E) Strongly Agree

6. Most people use mathematics in their jobs.

1 A) Strongly Disagree
4 B) Disagree
8 C) Do not know
61 D) Agree
26 E) Strongly Agree

7. When I leave school, I would like a job where I have to use mathematics

6 A) Strongly Disagree
14 B) Disagree
38 C) Do not know
31 D) Agree
11 E) Strongly Agree

For each of the next four items, three answers are needed.

A) Tell how important you think the topic is.
B) Tell how easy you think the topic is.
C) Tell how much you like the topic.

If you are not sure what a topic means, leave its three answers blank

8 Learning geometry

A	B	C
2 not at all important	2 very difficult	5 dislike a lot
8 not important	19 difficult	20 dislike
19 undecided	20 undecided	19 undecided
59 important	49 easy	47 like
12 very important	11 very easy	10 like a lot

9 Working with data and graphs

A	B	C
2 not at all important	2 very difficult	4 dislike a lot
6 not important	15 difficult	15 dislike
20 undecided	25 undecided	24 undecided
53 important	44 easy	44 like
19 very important	15 very easy	13 like a lot

10 Learning to use calculators

A	B	C
3 not at all important	0 very difficult	1 dislike a lot
12 not important	2 difficult	4 dislike
10 undecided	5 undecided	10 undecided
46 important	35 easy	47 like
29 very important	58 very easy	38 like a lot

11. Learning strategies for problem solving like looking for patterns and making models

A	B	C
2 not at all important	4 very difficult	8 dislike a lot
6 not important	29 difficult	22 dislike
17 undecided	30 undecided	25 undecided
46 important	32 easy	34 like
29 very important	7 very easy	12 like a lot

8. Adding, subtracting, and multiplying fractions

A	B	C
1 not at all important	1 very difficult	5 dislike a lot
5 not important	11 difficult	19 dislike
11 undecided	16 undecided	19 undecided
58 important	53 easy	47 like
26 very important	20 very easy	9 like a lot

9 Adding, subtracting, and multiplying decimals

A	B	C
1 not at all important	1 very difficult	5 dislike a lot
3 not important	11 difficult	19 dislike
10 undecided	15 undecided	20 undecided
55 important	48 easy	46 like
31 very important	24 very easy	10 like a lot

10 Working with percents

A	B	C
1 not at all important	2 very difficult	5 dislike a lot
2 not important	15 difficult	15 dislike
10 undecided	24 undecided	24 undecided
46 important	40 easy	40 like
41 very important	19 very easy	16 like a lot

11. Learning about estimation

A	B	C
3 not at all important	1 very difficult	6 dislike a lot
9 not important	7 difficult	19 dislike
17 undecided	16 undecided	23 undecided
50 important	43 easy	40 like
22 very important	32 very easy	12 like a lot

8. Memorizing basic facts

A	B	C
1 not at all important	1 very difficult	4 dislike a lot
2 not important	15 difficult	20 dislike
6 undecided	18 undecided	26 undecided
55 important	52 easy	44 like
36 very important	12 very easy	6 like a lot

9. Solving equations

A	B	C
1 not at all important	1 very difficult	6 dislike a lot
3 not important	17 difficult	21 dislike
8 undecided	22 undecided	20 undecided
54 important	49 easy	44 like
35 very important	11 very easy	9 like a lot

10. Working with perimeter, area, and volume

A	B	C
2 not at all important	3 very difficult	8 dislike a lot
5 not important	19 difficult	23 dislike
16 undecided	18 undecided	20 undecided
54 important	44 easy	38 like
23 very important	17 very easy	11 like a lot

11. Working with integers

A	B	C
2 not at all important	2 very difficult	5 dislike a lot
7 not important	13 difficult	15 dislike
34 undecided	38 undecided	40 undecided
42 important	32 easy	30 like
15 very important	15 very easy	10 like a lot

12. We use computers in our mathematics class.

2 A) Almost every day
4 B) Often
9 C) Sometimes
14 D) Rarely
71 E) Never

13 The teacher helps individual students.

43 A) Almost every day
29 B) Often
21 C) Sometimes
5 D) Rarely
1 E) Never

14. We review our homework and discuss solutions.

55 A) Almost every day
22 B) Often
15 C) Sometimes
6 D) Rarely
2 E) Never

12. The teacher shows us what to do on the blackboard or overhead projector.

61 A) Almost every day
20 B) Often
11 C) Sometimes
5 D) Rarely
3 E) Never

13 We work individually from our text books or on other exercises the teacher assigns.

59 A) Almost every day
24 B) Often
12 C) Sometimes
4 D) Rarely
1 E) Never

14. We use calculators.

6 A) Almost every day
12 B) Often
36 C) Sometimes
36 D) Rarely
10 E) Never

12. We have quizzes or tests.

5 A) Almost every day
34 B) Often
49 C) Sometimes
11 D) Rarely
1 E) Never

13. We work in small groups.

14 A) Almost every day
16 B) Often
26 C) Sometimes
30 D) Rarely
14 E) Never

14. We use objects like blocks, counters, fraction bars, and geoboards

1 A) Almost every day
3 B) Often
13 C) Sometimes
37 D) Rarely
47 E) Never

GRADE 10 STUDENT BACKGROUND INFORMATION

For each item, shade in the appropriate space on the answer sheet.

1. Sex

50 A) Male
50 B) Female

2. Age

1 A) 14 or less 8 D) 17
47 B) 15 1 E) 18
42 C) 16 1 F) 19 or more

3. What program are you in?

97 A) Regular program in English
3 B) French Immersion
1 C) Programme-cadre de français

4. What mathematics course are you currently taking (If you are not taking one this semester, which course did you take last semester)?

0 A) Math 8
1 B) Math 9
1 C) Math 9A
70 D) Math 10
25 E) Math 10A
0 F) Introductory Math 11
0 G) Math 11A
1 H) Math 11
0 I) Algebra 11
0 J) Algebra 12
2 K) A mathematics course not on this list
0 L) I am not taking a mathematics course this year.

5. Which of the following best describes the mathematics course you took or are taking this year?

75 A) A ten-month course
12 B) A semestered course beginning in September
10 C) A semestered course beginning in January or February
0 D) I am not taking a mathematics course this year.
2 E) Other

6. What made you decide to take the mathematics course you are currently taking (or the one you took last semester)? You may choose more than one response.

Actual Numbers
2095 A) The counsellor suggested it.
2271 B) My parent(s) or guardian(s) suggested it.
4037 C) My last year's mathematics teacher suggested it.
11043 D) I decided on my own.
4590 E) I had no choice because of my marks in previous mathematics courses.
13520 F) It is required for the next mathematics course I want to take.
869 G) Most of my friends take this course.
2924 H) I took the course because I am good at mathematics.
4705 I) Some other reason

7. Which mathematics course(s) do you intend to take in both Grades 11 and 12? Mark all that apply.

Actual Numbers
420 A) None
443 B) Math 10
327 C) Math 10A
20676 D) Math 11
7044 E) Introductory Math 11
3958 F) Math 11A
3321 G) Introductory Accounting 11
13672 H) Math 12
431 I) Survey Math 12
3443 J) An enriched mathematics course (e.g. Advanced Placement, International Baccalaureate, Calculus, etc.)
1851 K) A mathematics course not on this list

8. What do you plan to do after leaving secondary school? Choose one.

6 A) Attend a business school or technical college
5 B) Attend a vocational, art, or trade training school
11 C) Attend a community college: university transfer program
7 D) Attend a community college: career program
34 E) Attend university
4 F) Look for a full-time job
9 G) Take a year off and then return to school
1 H) Take a year off and then look for a job
7 I) Other plans
15 J) Undecided

For the next three items, decide to what extent you agree or disagree

9. You have to be able to do mathematics to get a good job.

3 A) Strongly Disagree
13 B) Disagree
9 C) Do not know
59 D) Agree
17 E) Strongly Agree

10. Most people use mathematics in their jobs.

2 A) Strongly Disagree
12 B) Disagree
14 C) Do not know
62 D) Agree
10 E) Strongly Agree

11. When I leave school, I would like a job where I have to use mathematics

15 A) Strongly Disagree
20 B) Disagree
35 C) Do not know
24 D) Agree
6 E) Strongly Agree

For each of the next three items, three answers are needed

A) Tell how important you think the topic is.
B) Tell how easy you think the topic is.
C) Tell how much you like the topic.

If you are not sure what a topic means, leave its three answers blank

12. Finding area, perimeter, and volume

A		B		C	
5	not at all important	2	very difficult	9	dislike a lot
17	not important	15	difficult	27	dislike
22	undecided	17	undecided	28	undecided
50	important	52	easy	34	like
6	very important	15	very easy	2	like a lot

13. Problem Solving

A		B		C	
4	not at all important	6	very difficult	13	dislike a lot
8	not important	30	difficult	27	dislike
13	undecided	24	undecided	24	undecided
53	important	35	easy	32	like
22	very important	5	very easy	5	like a lot

14. Solving equations and simplifying expressions

A		B		C	
6	not at all important	4	very difficult	9	dislike a lot
14	not important	20	difficult	21	dislike
23	undecided	25	undecided	28	undecided
48	important	41	easy	35	like
10	very important	10	very easy	7	like a lot

12. Working with exponents

A		B		C	
7	not at all important	1	very difficult	7	dislike a lot
21	not important	16	difficult	25	dislike
29	undecided	18	undecided	30	undecided
41	important	55	easy	36	like
3	very important	10	very easy	2	like a lot

13. Problem Solving

A		B		C	
4	not at all important	6	very difficult	12	dislike a lot
8	not important	34	difficult	29	dislike
12	undecided	23	undecided	23	undecided
52	important	32	easy	31	like
24	very important	5	very easy	6	like a lot

14. Estimating answers

A		B		C	
4	not at all important	2	very difficult	7	dislike a lot
10	not important	10	difficult	19	dislike
19	undecided	24	undecided	35	undecided
52	important	49	easy	35	like
15	very important	15	very easy	5	like a lot

12. Geometry

A		B		C	
6	not at all important	4	very difficult	10	dislike a lot
20	not important	27	difficult	26	dislike
26	undecided	21	undecided	22	undecided
43	important	42	easy	37	like
4	very important	7	very easy	5	like a lot

13. Data Analysis

A		B		C	
5	not at all important	3	very difficult	7	dislike a lot
7	not important	16	difficult	16	dislike
36	undecided	50	undecided	52	undecided
43	important	25	easy	23	like
9	very important	6	very easy	3	like a lot

14. Trigonometry

A		B		C	
9	not at all important	11	very difficult	13	dislike a lot
16	not important	24	difficult	18	dislike
37	undecided	36	undecided	41	undecided
33	important	23	easy	23	like
6	very important	6	very easy	6	like a lot

14. Working with decimals, fractions, and percent

A		B		C	
2	not at all important	3	very difficult	7	dislike a lot
3	not important	18	difficult	19	dislike
8	undecided	17	undecided	23	undecided
53	important	18	easy	43	like
34	very important	14	very easy	8	like a lot

15. We go over our homework and discuss solutions.

55 A) Almost every period
20 B) Often
14 C) Sometimes
7 D) Rarely
5 E) Never

18. The teacher works with individual students.

- 24 A) Almost every period
- 29 B) Often
- 29 C) Sometimes
- 13 D) Rarely
- 4 E) Never

17. We use concrete materials (dice, coins, laboratory manipulatives, etc.) to assist understanding.

- 2 A) Almost every period
- 4 B) Often
- 13 C) Sometimes
- 29 D) Rarely
- 53 E) Never

15. The teacher lectures and we take notes from the blackboard or overhead projector.

- 43 A) Almost every period
- 21 B) Often
- 18 C) Sometimes
- 12 D) Rarely
- 7 E) Never

16. We work individually from our textbooks or on other exercises which the teacher assigns.

- 51 A) Almost every period
- 27 B) Often
- 15 C) Sometimes
- 6 D) Rarely
- 2 E) Never

17. We use calculators.

- 43 A) Almost every period
- 28 B) Often
- 19 C) Sometimes
- 7 D) Rarely
- 3 E) Never

15. We use computers in our mathematics class.

- 2 A) Almost every period
- 2 B) Often
- 3 C) Sometimes
- 8 D) Rarely
- 86 E) Never

16. We have quizzes or tests in mathematics.

- 10 A) Almost every period
- 59 B) Often
- 28 C) Sometimes
- 3 D) Rarely
- 1 E) Never

17. We work in small groups in our mathematics class.

- 10 A) Almost every period
- 8 B) Often
- 18 C) Sometimes
- 25 D) Rarely
- 39 E) Never

APPENDIX I

Q Forms

GRADE 4 FORM Q1

Are you a boy or girl? ________ What is your age ? ______

BEFORE YOU START THE PROBLEMS,
ANSWER THE QUESTIONS BELOW.

1 After you read a problem and don't understand it, what do you do?

2 After you get an answer to a problem, what do you do

Try your best to solve the problems after you turn this page.
Even if you are not sure how to solve a problem, give it a try.

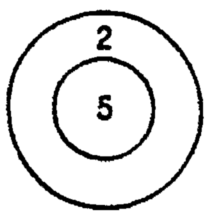
Show all your work neatly. Explain your work completely and clearly.
Always write a final answer statement.
If you finish early, go back and check your work.

SHOW AND EXPLAIN ALL YOUR WORK.

1 At a fruit stand there were 5 bunches of bananas with 4 bananas in each bunch and 3 bunches of bananas with 6 bananas in each bunch. If you bought all the bananas, and your friends ate 15 of them, how many bananas would be left?

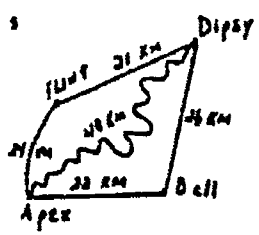
2 In Holly Park School there are 430 pupils and 14 teachers. There are 65 pupils in two Grade 4 classes. One Grade 4 class has 31 pupils. How many pupils are in the other Grade 4 class?

3 If you hit the target outside the bull's eye you score 2 points. If you hit the target inside the bull's eye, you get 5 points. Carlo hit the target 8 times and scored 34 points. How many times did Carlo hit the bull's eye?



4. Small candies cost 2 cents each and large candies cost 5 cents each. Susan bought 3 candies.

How many different amounts could Susan have spent?

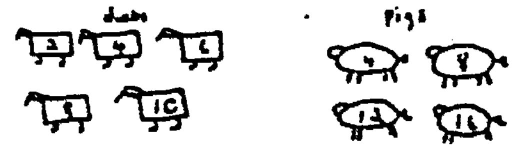
5 

Billie and Millie took a bus from Apex to Dipsy.
Billie took the shortest route.
Millie took the longest route.
How much farther did Millie have to travel?

6 We want to number the pages of a book with 222 pages.
How many times will a 7 be printed?

7. In a barnyard there are 10 animals.
Some are pigs and some are ducks.
Altogether the animals have 28 legs.
We want to find how many of the animals are pigs.

Tim tried to solve the problem this way:



out of the 10 animals
there are 4 pigs.

Look at Tim's work. Answer these questions about his work.

1. Explain clearly how you think Tim tried to solve the problem.

2. Is Tim's way of solving the problem a good one? Tell why you think it is or is not a good way.

GRADE 4 FORM Q2

Are you a boy or girl? ________ What is your age ? ______

BEFORE YOU START THE PROBLEMS, LOOK AT THE STATEMENTS BELOW.
CIRCLE THE ANSWERS THAT TELL BEST HOW YOU FEEL ABOUT MATH PROBLEMS.

1. I enjoy solving math problems.

Strongly agree Agree Undecided Disagree Strongly disagree

2. When my teacher gives us math problems to solve, I get uncomfortable.

Strongly agree Agree Undecided Disagree Strongly disagree

3. Once I start a math problem I don't give up until I solve it.

Strongly agree Agree Undecided Disagree Strongly disagree

4. I would rather solve only easy math problems.

Strongly agree Agree Undecided Disagree Strongly disagree

5. Problems that make you think are more fun than easy problems.

Strongly agree Agree Undecided Disagree Strongly disagree

6. If I had the choice, I would rather solve math problems than do arithmetic drills or exercises.

Strongly agree Agree Undecided Disagree Strongly disagree

7. Math would be more interesting if we had more problems.

Strongly agree Agree Undecided Disagree Strongly disagree

8. I think I'm good at solving problems.

Strongly agree Agree Undecided Disagree Strongly disagree

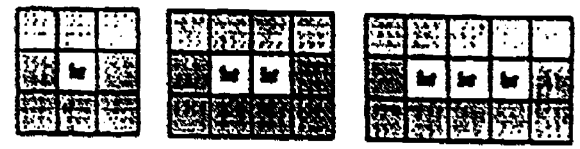
Try your best to solve the problems after you turn this page.
Even if you are not sure how to solve a problem, give it a try.

Show all your work neatly. Explain your work completely and clearly.
Always write a final answer statement.
If you finish early, go back and check your work.

SHOW AND EXPLAIN ALL YOUR WORK.

1. At a fruit stand there were 5 bunches of bananas with 4 bananas in each bunch and 3 bunches with 6 bananas in each. If you bought all the bananas, would you have enough to give each child in your class a banana?

2. There are 12 rows of apple trees and 8 rows of cherry trees.
There are 6 trees in every row.
How many apple trees are there?

3 

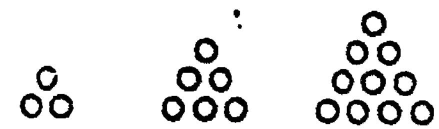
8 squares around 1 cat

10 squares around 2 cats

12 squares around 3 cats

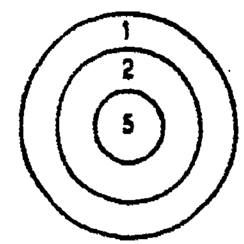
How many squares are needed to go around 10 cats?

4 The Oceanwest Chocolate Shop arranges chocolates in boxes in the shape of triangles as shown.
How many chocolates would there be in a box with 10 rows of chocolates?



5. Petra read a book with 100 pages in 4 days.
Each day after the first day, she read 10 pages more than the day before.
How many pages did she read on the fourth day?

6. Candies are sold for 5 cents, 10 cents, and 15 cents each.
You have 50 cents to spend.
There is more than one way to spend all your money and buy exactly 5 candies.
Show as many different ways as you can.

7. 

You get 1 point or 2 points or 5 points for each hit on the target.

How many different scores could you make if you hit the target twice?

Jackie tried to solve the problem this way:

Look at Jackie's work. Answer these questions about his work:

1. Explain how you think Jackie tried to solve the problem.

2. Is Jackie's way of solving the problem a good one?
Tell why or why not.

GRADE 7 FORM Q1

Are you a boy or a girl? ________   What is your age ? ________

BEFORE YOU START THE PROBLEMS,
ANSWER THE QUESTIONS BELOW.

1 After you read a problem and don't understand it, what do you do?

2 After you get an answer to a problem, what do you do

Try your best to solve the problems after you turn this page.
Even if you are not sure how to solve a problem, give it a try.

Show all your work neatly. Explain your work completely and clearly.
Always write a final answer statement.
If you finish early, go back and check your work.

If you use a calculator, be sure to write the numbers
and calculations that you use on your paper.

SHOW AND EXPLAIN ALL YOUR WORK.

1 A compact car fuel tank holds 35 L of gasoline
The car uses 8 L every 100 km.
How much gasoline would be left after driving 275 km?

2 In a music store tapes are sold for $5, $10, and $15.
You plan to spend $30 on tapes.
Show all the different combinations of tapes you could buy.

3 A music club raised $123 to buy tickets for a concert.
Tickets cost $9 each.
After buying tickets for every club member, $17 was left.
How many members are in the music club?

4 We want to print the page numbers in a book of 322 pages.
How many times would the digit 7 be printed?

5 At a rock concert 10 000 tickets were sold
The tickets were numbered from 1 to 10 000.
Every person who had a ticket number with AT LEAST 3 DIGITS THE SAME
was given a free pass for another concert.
How many ticket holders got free passes?

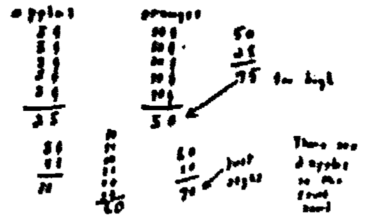
Here are two examples of numbers with two digits the same   747   5567

Here are two examples of numbers with three digits the same   6676   8880

6 A hockey team scored 70 goals in 24 games
In 10 of the games the team scored 2 goals in each game
In the other games they scored either 3 goals or 4 goals
The team won only when they scored 4 goals
How many games did the team win?

7 A bowl contains 10 apples and oranges.
Apples cost 5 cents each and oranges cost 10 cents each.
All together the fruit is worth 70 cents.
We want to find how many apples are in the bowl.

Beth tried to solve the problem this way.



Try to follow Beth's work and solution. Then answer these questions.

1. Is Beth's way of solving the problem a good one? Tell why you think it is or is not a good way.

2. Did Beth get the right answer? Explain why she did or did not

GRADE 7 FORM Q2

Are you a boy or girl? ________   What is your age ? ________

BEFORE YOU START THE PROBLEMS, LOOK AT THE STATEMENTS BELOW
CIRCLE THE ANSWERS THAT TELL BEST HOW YOU FEEL ABOUT MATH PROBLEMS

1. I enjoy solving math problems.
Strongly agree   Agree   Undecided   Disagree   Strongly disagree
2. When my teacher gives us math problems to solve, I get uncomfortable.
Strongly agree   Agree   Undecided   Disagree   Strongly disagree
3 Once I start a math problem I don't give up until I solve it.
Strongly agree   Agree   Undecided   Disagree   Strongly disagree
4. I would rather solve only easy math problems.
Strongly agree   Agree   Undecided   Disagree   Strongly disagree
5. Problems that make you think are more fun than easy problems
Strongly agree   Agree   Undecided   Disagree   Strongly disagree
6 If I had the choice, I would rather solve math problems than do arithmetic drills or exercises
Strongly agree   Agree   Undecided   Disagree   Strongly disagree
7 Math would be more interesting if we had more problems
Strongly agree   Agree   Undecided   Disagree   Strongly disagree
8. I think I'm good at solving problems
Strongly agree   Agree   Undecided   Disagree   Strongly disagree

Try your best to solve the problems after you turn the page
Even if you are not sure how to solve a problem, give it a try

Show all your work neatly. Explain your work completely and clearly
Always write a final answer statement.
If you finish early, go back and check your work.

SHOW AND EXPLAIN ALL YOUR WORK

1. Mr. Sim has a garden in the shape of a rectangle.
The garden is twice as long as it is wide.
It takes 24 m of fencing to go around the garden.
What is the area of the garden?

2 Rosie began a jogging program on Monday and finished the next Sunday.
Every day but the first day, she jogged 500 m more than she
jogged the day before.
On Sunday she jogged 5000 m.
How far did she jog on Monday?

3 Limericks are funny poems with 5 lines.
Sonnets are serious poems with 14 lines.
Chad read a collection of sonnets and limericks with a total of 96 lines.
How many sonnets did Chad read?

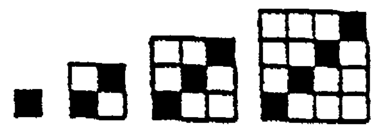
4 A hockey team played 32 games.
In one fourth of the games the team scored 4 goals in each game
In all the other games they scored either 2 goals or 3 goals.
They had 4 more 3-goal games than 2-goal games.
The team lost only when it scored 2 goals.
It won all the other games.
How many games did the team win?

5 Mike, Larry, and Les earned money mowing lawns.
One week Mike worked for 20 h, Larry worked for 12 h,
and Les worked for 18 h.

a) What percent of the total number of hours did Mike work?

b) During that week the boys were paid a total of $225. How much of the money should Mike receive?

6 Look at the pattern of black and white square tiles



How many BLACK tiles should be in the TENTH figure?

Black tiles cost $3 and white tiles cost $1.
How much will a square floor with 20 tiles on each side cost?

7. A bowl contains 10 items of fruit.
Some are apples and some are oranges.
Apples cost 5 cents each, and oranges cost 10 cents each
All together the 10 apples and oranges cost 70 cents
We want to find how many apples are in the bowl

Kelly tried to solve the problem this way:

10 x 5 = 50   8 x 5 = 40
2 x 10 = 20   3 x 10 = 30
70
4 x 10 = 40
6 x 5 = 30

There were 30 apples in the bowl.

Try to follow Kelly's work and solution. Then answer these questions

1. Is Kelly's way of solving the problem a good one?
Tell why you think it is or is not a good way

2 Did Kelly get the right answer?
Explain why she did or did not

Appendix I

GRADE 10 FORM Q1

Are you male or female? ________ What is your age ? ________

BEFORE YOU START THE PROBLEMS,
ANSWER THE QUESTIONS BELOW.

1 After you read a problem and don't understand it, what do you do?

2 After you get an answer to a problem, what do you do

Try your best to solve the problems after you turn this page.
Even if you are not sure how to solve a problem, give it a try.

Show all your work neatly. Explain your work completely and clearly
Always write a final answer statement
If you finish early, go back and check your work.

If you use a calculator, be sure to write the numbers
and calculations that you use on your paper.

SHOW AND EXPLAIN ALL YOUR WORK

1 Mike, Larry, and Lee earned money mowing lawns.
One week Mike worked for 20 h, Larry worked for 12 h, and
Lee worked for 10 h.

a) What percent of the total hours did Mike work?

b) That week the boys were paid a total of $323.
How much of the money should Mike receive?

2 Mr Mason drove for 4 hours at 80 km/h.
He drove 1 more hour in heavy traffic at 40 km/h.
What was his average speed for the trip?

3 We can write any whole number using the digits 0 to 9
59 has 2 digits: 5 and 9
798 has 3 digits: 7, 9, and 8.
4633 has 4 digits: 4, 6, and 3 used twice.
In numbering the pages of a book, 777 digits were used.
How many pages are in the book?

4 In a music store tapes are sold for $5, $10, and $15
You plan to spend $30 on tapes.
Show all the different combinations of tapes you can buy

5 A hockey team scored a total of 70 goals in 24 games.
In every one of its first 10 games the team scored 2 goals
In each of its other games the team scored either 3 goals or 4 goals.
The team won only when they scored 4 goals.

How many games did the team win?

6 Tina and Lena are running and walking around a track.
Tina runs half way and walks the other half.
Lena runs half the time and walks half the time.
Whenever they run, Tina and Lena run at the same speed.
Whenever they slow down to walk, they walk at the same speed
Who takes less time to circle the track?
Explain your thinking.

7. A litre of asphalt paint will cover 6 m^2 of surface
The paint is sold in cans of 5 L only.
How many cans are needed to paint a driveway 15 m long and 3 m wide?

Jill tried to solve the problem this way.

$A = l \times w$
$15 \times 3 = 45\ m^2$ area of driveway
$45 \div 6 = 7.5$
7.5 cans are needed

Answer these questions about Jill's work:

1. Does Jill's solution show that she understands and uses the problem facts well? Explain why or why not?

2. Is Jill's answer correct? Explain why or why not.

GRADE 10 FORM Q2

Are you male or female? ________ What is your age ? ________

BEFORE YOU START THE PROBLEMS, LOOK AT THE STATEMENTS BELOW
CIRCLE THE ANSWERS THAT TELL BEST HOW YOU FEEL ABOUT MATH PROBLEMS.

1. I enjoy solving math problems.

Strongly agree Agree Undecided Disagree Strongly disagree

2. When my teacher gives us math problems to solve, I get uncomfortable.

Strongly agree Agree Undecided Disagree Strongly disagree

3. Once I start a math problem I don't give up until I solve it.

Strongly agree Agree Undecided Disagree Strongly disagree

4. I would rather solve only easy math problems.

Strongly agree Agree Undecided Disagree Strongly disagree

5. Problems that make you think are more fun than easy problems.

Strongly agree Agree Undecided Disagree Strongly disagree

6. If I had the choice, I would rather solve math problems than do arithmetic drills or exercises

Strongly agree Agree Undecided Disagree Strongly disagree

7. Math would be more interesting if we had more problems.

Strongly agree Agree Undecided Disagree Strongly disagree

8. I think I am good at solving problems.

Strongly agree Agree Undecided Disagree Strongly disagree

Try your best to solve the problems after you turn this page.
Even if you are not sure how to solve a problem, give it a try.

Show all your work neatly. Explain your work completely and clearly.
Always write a final answer statement.
If you finish early, go back and check your work.

SHOW AND EXPLAIN ALL WORK

1. A plane took off with a full load of 115 000 L of jet fuel.
The plane used 9000 L of fuel per hour.
It flew at an average speed of 900 km/h.
When the plane landed, it had 44 000 L of jet fuel left.
How long was the flight?

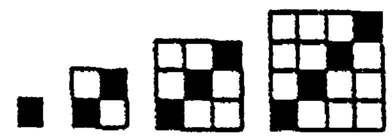
2 A litre of asphalt paint will cover about 6 m^2 of surface.
The paint is sold in cans of 5 L.
How many cans of paint are needed to paint a driveway
15 m long and 3 m wide?

3 At a rock concert 10 000 tickets were sold.
The tickets were numbered from 1 to 10 000.
Every person who had a ticket number with AT LEAST 3 DIGITS THE SAME
was given a free pass for another concert.
How many ticket holders got free passes?

Here are two examples of numbers with two digits the same: 747 3567

Here are two examples of numbers with three digits the same: 9838 6660

4 Look at the pattern of black and white square tiles.



How many BLACK tiles should be in the TENTH figure?

Black tiles cost $3 and white tiles cost $1.
How much will a square floor with 20 tiles on each side cost?

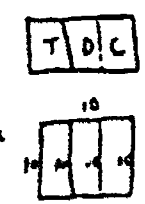
5 Wide World Airlines has a fleet of 24 planes with either 2, 3, or 4 engines
The planes have a total of 70 engines.
Ten of the planes have exactly 2 engines each.
How many planes have exactly 4 engines each?

6 We want to print the page numbers in a book of 222 pages.
How many times would the digit 7 be used?

7. A farmer wants to fence in his turkeys, ducks, and chickens in separate rectangular pens.
He plans to use two separating fences inside one large pen to make the three separate enclosures using a total of 60 m of fencing
He wants the total area of the three pens to be as large as possible
How long and how wide should the pen be?

Frank tried to solve the problem this way.

The pens will look like this.
You need a top side, bottom side, two end sides, and two separating sides inside the pens.
Just divide 60 by 6 to get each side.
The pen is 10 m long and 10 m wide



Answer these questions about Frank's work.

1. Does Frank's work show that he understands the problem?
Explain why or why not.

2. Does Frank's solution give the greatest total area?
Explain why or why not.

APPENDIX J

Teacher Questionnaires

GRADE 4 TEACHER QUESTIONNAIRE

Section 1: Background Information

Your responses to the items in this section will help us put together a description of the population of mathematics teachers in the province.

1. Sex

36 A) Male
64 B) Female

2. For how many years will you have been teaching mathematics as of June 1990?

16 A) 1-2 years
13 B) 3-5 years
18 C) 6-10 years
17 D) 11-15 years
36 E) More than 15 years

3. What percent of your current teaching load is mathematics?

71 A) 0 - 20%
26 B) 21 - 40%
2 C) 41 - 60%
0 D) 61 - 80%
1 E) 81-100%

4. To which of the following associations do you belong? Mark all that apply.

Actual Figures
21 A) National Council of Teachers of Mathematics
79 B) B.C. Association of Mathematics Teachers
495 C) Provincial Intermediate Teachers Association
222 D) B.C. Primary Teachers Association
12 E) *Association provinciale des professeurs de l'immersion et du programme-cadre*
21 F) Local Mathematics Specialist Association,
648 G) Other professional association(s)
763 H) None of the above

5. How often do you read educational professional journals?

37 A) Frequently (At least one every month)
46 B) Sometimes (Fewer than one every month)
17 C) Rarely

6. How many post-secondary courses in mathematics have you successfully completed? (e.g. For U.B.C. 3 units = 2 courses.)

24 A) 0
54 B) 1 or 2
23 C) 3 or more

7. How many post-secondary courses in mathematics methods (pedagogy) have you successfully completed? (e.g. For U.B.C. 3 units = 2 courses.)

20 A) 0
70 B) 1 or 2
10 C) 3 or more

Items 8-16 list a number of factors which might be used to explain why some students are not making satisfactory progress in mathematics. Tell how important you believe each factor to be in explaining students' failure to succeed at an appropriate level.

8. Lack of ability

58 A) a very important factor
38 B) a factor of minor importance
4 C) a very unimportant factor

9. Misbehavior

39 A) a very important factor
47 B) a factor of minor importance
14 C) a very unimportant factor

10. Indifference or lack of motivation (but not misbehavior)

70 A) a very important factor
26 B) a factor of minor importance
4 C) a very unimportant factor

11. Fear of mathematics

48 A) a very important factor
41 B) a factor of minor importance
11 C) a very unimportant factor

12. Absenteeism

48 A) a very important factor
34 B) a factor of minor importance
18 C) a very unimportant factor

13. Insufficient school time allocated to mathematics

33 A) a very important factor
41 B) a factor of minor importance
26 C) a very unimportant factor

14. Insufficient proficiency on your part in dealing with students having the kinds of difficulties found in the class

29 A) a very important factor
41 B) a factor of minor importance
30 C) a very unimportant factor

15. Limited resources and materials

42 A) a very important factor
44 B) a factor of minor importance
15 C) a very unimportant factor

16. Too many students in the class

70 A) a very important factor
23 B) a factor of minor importance
8 C) a very unimportant factor

Section 2: Implementation Information

Your responses to the following items will enable us to generate a composite picture of the curriculum as it has been implemented, identify the extent of implementation support available for teachers, and determine the opinions generally held about the new curriculum.

17. What is the length of each class period in mathematics?

3 A) 30 minutes
68 B) 31-45 minutes
27 C) 46-60 minutes
2 D) 61-75 minutes
0 E) More than 75 minutes

18. How many periods of mathematics instruction does this class receive each week?

1 A) 3
13 B) 4
80 C) 5
5 D) 6
1 E) More than 6

19. As of June 1990, this school will have been using the new provincial mathematics curriculum for

6 A) 1 year.
44 B) 2 years.
45 C) 3 years (or more).
4 D) This school does not use the new curriculum.

20. In the past three years, has your approach to teaching mathematics changed?

78 A) Yes
22 B) No

21. The following is a list of teaching strategies which may reflect changes in your approach to teaching mathematics. Mark all that apply.

Actual Numbers

1562 A) I am more likely to use cooperative learning groups.
1167 B) I am more likely to encourage individuals to progress at their own rate.
1554 C) I am more likely to have students use concrete materials.
1018 D) I am more likely to encourage students to use calculators
769 E) I am more likely to have students use computers.
1556 F) I am more likely to focus on problem solving processes.
1078 G) I am more likely to use an activities approach to teaching mathematics.
109 H) Other. Please specify________________

22. In the past three years has your approach to student evaluation in mathematics changed?

58 A) Yes
42 B) No

23. The following is a list of evaluation strategies which may reflect changes in your approach to student evaluation in mathematics.
Mark all that apply.

Actual Numbers

744 A) I am more likely to have students involved in self assessment.
1410 B) I am more likely to assess students through informal observations during class time.
888 C) I am more likely to give frequent quizzes and tests
597 D) I am less likely to give frequent quizzes and tests.
1506 E) I am more likely to evaluate problem-solving strategies as well as answers
61 F) Other. Please specify________________

24. In terms of assisting me in planning my mathematics instruction, the new Mathematics Curriculum Guide is

10 A) extremely helpful
34 B) very helpful.
47 C) somewhat helpful
6 D) not very helpful
2 E) of no help at all

25. The mathematics text which I use most often is

53 A) *Journeys in Math 4* (Ginn).
21 B) *Math Quest 4* (Addison-Wesley).
17 C) *Mathematics 4* (Houghton Mifflin).
1 D) *Mathematics 4 Problem Solving Activities Booklet* (Houghton Mifflin).
1 E) Other. Please specify________________

26. There is a good match between the text and the curriculum.

12 A) Strongly agree
65 B) Agree
16 C) Undecided
7 D) Disagree
1 E) Strongly disagree

27. The text is written at an appropriate level of difficulty for the students I teach

17 A) Strongly agree
66 B) Agree
8 C) Undecided
8 D) Disagree
1 E) Strongly disagree

28. The mathematics materials needed to support the new mathematics curriculum (including calculators) have been easy to obtain.

7 A) Strongly agree
37 B) Agree
18 C) Undecided
29 D) Disagree
9 E) Strongly disagree

29. I am aware of the availability of in-service programs to support the implementation of the new curriculum (including Ministry-sponsored, District-sponsored, school based, and others) in the following areas of the new curriculum. Mark all that apply.

Actual Numbers

1113 A) Problem solving
328 B) Data analysis
652 C) Geometry
524 D) Measurement
104 E) Algebra
297 F) Other
584 G) None

30. Over the last three years, I have attended

23 A) no in-service sessions in mathematics.
49 B) 1-2 in-service sessions in mathematics
28 C) 3 or more in-service sessions in mathematics

31. The in-service support for the implementation of the new curriculum was effective

7 A) Strongly agree
38 B) Agree
40 C) Undecided
12 D) Disagree
4 E) Strongly disagree

32. The new curriculum helps students learn effective problem-solving strategies.

8 A) Strongly agree
58 B) Agree
30 C) Undecided
4 D) Disagree
0 E) Strongly disagree

33. The teaching strategies suggested for the new curriculum are effective: e.g. use of manipulatives, use of calculators.

18 A) Strongly agree
62 B) Agree
18 C) Undecided
2 D) Disagree
0 E) Strongly disagree

34 The new curriculum meets the needs of a broad range of student abilities.

6 A) Strongly agree
55 B) Agree
29 C) Undecided
9 D) Disagree
1 E) Strongly disagree

35 Students find the new prog..am interesting

5 A) Strongly agree
62 B) Agree
28 C) Undecided
4 D) Disagree
0 E) Strongly disagree

36. Students see how the mathematics they are learning is relevant to their everyday lives

5 A) Strongly agree
52 B) Agree
34 C) Undecided
9 D) Disagree
1 E) Strongly disagree

37. There is a logical progression of concepts for students to learn as they progress through the grades.

14 A) Strongly agree
70 B) Agree
13 C) Undecided
3 D) Disagree
0 E) Strongly disagree

38. The amount of material to be covered at each grade level is appropriate.

6 A) Strongly agree
44 B) Agree
19 C) Undecided
27 D) Disagree
5 E) Strongly disagree

Section 3: Classroom Practices

> Your responses to the items in this section will enable us to describe the kinds of classroom practices associated with the teaching of the new curriculum. Students will be asked the same questions, and the data from both sources will enable us to discuss teaching practices as they relate to achievement at the provincial level.

For the items 39-41, think of mathematics classes during a typical school week

39 I show students what to do on the blackboard or the overhead projector

70 A) Almost every day
23 B) Often
6 C) Sometimes
1 D) Rarely
0 E) Never

40 Students use objects like blocks and counters

5 A) Almost every day
31 B) Often
46 C) Sometimes
16 D) Rarely
2 E) Never

41 Students work individually on problems from textbooks or other exercises as assigned

47 A) Almost every day
36 B) Often
15 C) Sometimes
2 D) Rarely
0 E) Never

Section 4: Mathematics in School

> Teacher and student perceptions about the importance and difficulty of mathematics topics have a great bearing on student achievement. In order to contribute to our understanding of these relationships, please answer the following questions.

For each of the next items in this scale, three answers are needed.

A) Tell how important you think the topic is for this class.
B) Tell how easy it is to teach the topic to this class.
C) Tell how much you like teaching the topic to this class

42. Adding, subtracting, multiplying, and dividing whole numbers

A		B		C	
0	not at all important	0	very difficult	0	dislike a lot
0	not important	19	difficult	1	dislike
0	undecided	12	undecided	4	undecided
16	important	59	easy	59	like
84	very important	10	very easy	35	like a lot

43. Learning about decimals

A		B		C	
1	not at all important	4	very difficult	0	dislike a lot
3	not important	26	difficult	4	dislike
7	undecided	20	undecided	18	undecided
50	important	44	easy	58	like
39	very important	6	very easy	19	like a lot

44 Learning about fractions

A		B		C	
1	not at all important	3	very difficult	1	dislike a lot
9	not important	24	difficult	4	dislike
14	undecided	19	undecided	15	undecided
56	important	47	easy	61	like
20	very important	7	very easy	20	like a lot

45 Learning how to estimate

A		B		C	
0	not at all important	6	very difficult	1	dislike a lot
2	not important	36	difficult	9	dislike
7	undecided	18	undecided	21	undecided
44	important	34	easy	53	like
47	very important	5	very easy	16	like a lot

GRADE 7 TEACHER QUESTIONNAIRE

Section 1: Background Information

Your responses to the items in this section will help us put together a description of the population of mathematics teachers in the province.

1. Sex

66 A) Male
34 B) Female

2. For how many years will you have been teaching mathematics as of June 1990?

15 A) 1-2 years
15 B) 3-5 years
17 C) 6-10 years
19 D) 11-15 years
34 E) More than 15 years

3. What percent of your current teaching load is mathematics?

67 A) 0-20%
27 B) 21-40%
4 C) 41-60%
1 D) 61-80%
2 E) 81-100%

4. To which of the following associations do you belong?
Mark all that apply.

Actual Numbers
29 A) National Council of Teachers of Mathematics
57 B) B C. Association of Mathematics Teachers
413 C) Provincial Intermediate Teachers Association
75 D) B C. Primary Teachers Association
49 E) *Association provinciale des professeurs de l'immersion et du programme-cadre*
38 F) Local Mathematics Specialist Association,
705 G) Other professional association(s)
457 H) None of the above

5. How often do you read educational professional journals?

40 A) Frequently (At least one every month)
42 B) Sometimes (Fewer than one every month)
18 C) Rarely

6. How many post-secondary courses in mathematics have you successfully completed?
(e g. For U.B.C. 3 units = 2 courses)

23 A) 0
49 B) 1 or 2
28 C) 3 or more

7. How many post-secondary courses in mathematics methods (pedagogy) have you successfully completed? (e g. For U.B C. 3 units = 2 courses)

23 A) 0
65 B) 1 or 2
12 C) 3 or more

Items 8-16 list a number of factors which might be used to explain why some students are not making satisfactory progress in mathematics. Tell how important you believe each factor to be in explaining students' failure to succeed at an appropriate level

8. Lack of ability

54 A) a very important factor
42 B) a factor of minor importance
4 C) a very unimportant factor

9. Misbehavior

37 A) a very important factor
45 B) a factor of minor importance
18 C) a very unimportant factor

10. Indifference or lack of motivation (but not misbehavior)

71 A) a very important factor
26 B) a factor of minor importance
3 C) a very unimportant factor

11. Fear of mathematics

44 A) a very important factor
44 B) a factor of minor importance
13 C) a very unimportant factor

12. Absenteeism

46 A) a very important factor
33 B) a factor of minor importance
21 C) a very unimportant factor

13. Insufficient school time allocated to mathematics

29 A) a very important factor
42 B) a factor of minor importance
30 C) a very unimportant factor

14. Insufficient proficiency on your part in dealing with students having the kinds of difficulties found in the class

21 A) a very important factor
41 B) a factor of minor importance
38 C) a very unimportant factor

15. Limited resources and materials

28 A) a very important factor
48 B) a factor of minor importance
24 C) a very unimportant factor

16. Too many students in the class

61 A) a very important factor
27 B) a factor of minor importance
12 C) a very unimportant factor

Section 2: Implementation Information

Your responses to the following items will enable us to generate a composite picture of the curriculum as it has been implemented, identify the extent of implementation support available for teachers, and determine the opinions generally held about the new curriculum

17. What is the length of each class period in mathematics?

1 A) 30 minutes
51 B) 31-45 minutes
45 C) 46-60 minutes
2 D) 61-75 minutes
0 E) more than 75 minutes

18. How many periods of mathematics instruction does this class receive each week?

4 A) 3
13 B) 4
71 C) 5
10 D) 6
2 E) more than 6

19. As of June 1990, this school will have been using the new provincial mathematics curriculum for

11 A) 1 year.
43 B) 2 years.
43 C) 3 years (or more).
3 D) This school does not use the new curriculum.

20. In the past three years, has your approach to teaching mathematics changed?

76 A) Yes
24 B) No

21. The following is a list of teaching strategies which may reflect changes in your approach to teaching mathematics. Mark all that apply.

Actual Numbers
1295 A) I am more likely to use cooperative learning groups.
934 B) I am more likely to encourage individuals to progress at their own rate.
969 C) I am more likely to have students use concrete materials.
1228 D) I am more likely to encourage students to use calculators.
596 E) I am more likely to have students use computers.
1282 F) I am more likely to focus on problem solving processes.
696 G) I am more likely to use an activities approach to teaching mathematics.
112 H) Other. Please specify____________________

22. In the past three years has your approach to student evaluation in mathematics changed?

53 A) Yes
47 B) No

23. The following is a list of evaluation strategies which may reflect changes in your approach to student evaluation in mathematics.
Mark all that apply.

Actual Numbers
613 A) I am more likely to have students involved in self assessment.
970 B) I am more likely to assess students through informal observations during class time.
990 C) I am more likely to give frequent quizzes and tests.
332 D) I am less likely to give frequent quizzes and tests.
1194 E) I am more likely to evaluate problem solving strategies as well as answers
60 F) Other. Please specify____________________

24. In terms of assisting me in planning my mathematics instruction, the new Mathematics Curriculum Guide is

9 A) extremely helpful
33 B) very helpful.
47 C) somewhat helpful.
9 D) not very helpful.
3 E) of no help at all

25. The mathematics text which I use most often is

66 A) *Journeys in Math 7*, (Ginn).
23 B) *Mathematics 7*, (Houghton Mifflin).
3 C) *Mathematics 7, Problem Solving Activities Booklet* (Houghton Mifflin).
1 D) *Holt Math 7*, (Holt, Rinehart & Winston).
7 E) Other. Please specify____________________

26. There is a good match between the text and the curriculum.

11 A) Strongly agree
64 B) Agree
15 C) Undecided
9 D) Disagree
1 E) Strongly disagree

27. The text is written at an appropriate level of difficulty for the students I teach

13 A) Strongly agree
66 B) Agree
9 C) Undecided
11 D) Disagree
2 E) Strongly disagree

28. The mathematics materials needed to support the new mathematics curriculum (including calculators) have been easy to obtain.

9 A) Strongly agree
41 B) Agree
20 C) Undecided
24 D) Disagree
7 E) Strongly disagree

29. I am aware of the availability of in-service programs to support the implementation of the new curriculum (including Ministry-sponsored, District-sponsored, school-based, and others) in the following areas of the new curriculum. Mark all that apply.

Actual Numbers
889 A) Problem solving
367 B) Data analysis
567 C) Geometry
472 D) Measurement
237 E) Algebra
223 F) Other
566 G) None

30. Over the last three years, I have attended

25 A) no in-service sessions in mathematics.
45 B) 1-2 in-service sessions in mathematics.
30 C) 3 or more in-service sessions in mathematics.

31. The in-service support for the implementation of the new curriculum was effective

7 A) Strongly agree
31 B) Agree
41 C) Undecided
13 D) Disagree
6 E) Strongly disagree

32. The new curriculum helps students learn effective problem-solving strategies

6 A) Strongly agree
55 B) Agree
33 C) Undecided
6 D) Disagree
1 E) Strongly disagree

33. The teaching strategies suggested for the new curriculum are effective: e g use of manipulatives, use of calculators.

14 A) Strongly agree
59 B) Agree
23 C) Undecided
3 D) Disagree
0 E) Strongly disagree

34. The new curriculum meets the needs of a broad range of student abilities.

4 A) Strongly agree
48 B) Agree
34 C) Undecided
12 D) Disagree
1 E) Strongly disagree

35. Students find the new program interesting.

2 A) Strongly agree
44 B) Agree
44 C) Undecided
9 D) Disagree
0 E) Strongly disagree

36. Students see how the mathematics they are learning is relevant to their everyday lives

4 A) Strongly agree
47 B) Agree
33 C) Undecided
15 D) Disagree
2 E) Strongly disagree

37. There is a logical progression of concepts for students to learn as they progress through the grades.

11 A) Strongly agree
69 B) Agree
16 C) Undecided
5 D) Disagree
1 E) Strongly disagree

38. The amount of material to be covered at each grade level is appropriate.

4 A) Strongly agree
39 B) Agree
19 C) Undecided
29 D) Disagree
8 E) Strongly disagree

Section 3: Classroom Practices

Your responses to the items in this section will enable us to describe the kinds of classroom practices associated with the teaching of the new curriculum. Students will be asked the same questions, and the data from both sources will enable us to discuss teaching practices as they relate to achievement at the provincial level.

For the items 39-41, think of mathematics classes during a typical school week.

39. I show students what to do on the blackboard or the overhead projector.

75 A) Almost every day
17 B) Often
6 C) Sometimes
1 D) Rarely
0 E) Never

40. Students use calculators

17 A) Almost every day
36 B) Often
33 C) Sometimes
11 D) Rarely
3 E) Never

41. Students work individually on problems from textbooks or other exercises as assigned

54 A) Almost every day
30 B) Often
13 C) Sometimes
3 D) Rarely
0 E) Never

39. Students use objects like blocks, counters, fractions bars, and geoboards.

5 A) Almost every day
9 B) Often
31 C) Sometimes
41 D) Rarely
14 E) Never

40. Students answer quizzes or tests.

4 A) Almost every day
52 B) Often
40 C) Sometimes
3 D) Rarely
1 E) Never

41. Students work in small groups.

27 A) Almost every day
28 B) Often
32 C) Sometimes
11 D) Rarely
1 E) Never

39. Students use computers.

9 A) Almost every day
15 B) Often
27 C) Sometimes
27 D) Rarely
24 E) Never

40. I help individual students.

76 A) Almost every day
19 B) Often
4 C) Sometimes
1 D) Rarely
0 E) Never

41. We review homework assignments and I show students the correct answers

69 A) Almost every day
25 B) Often
4 C) Sometimes
1 D) Rarely
0 E) Never

Section 4: Mathematics in School

Teacher and student perceptions about the importance and difficulty of mathematics topics have a great bearing on student achievement. In order to contribute to our understanding of these relationships, please answer the following questions.

For each of the next items in this scale, three answers are needed.

A) Tell how important you think the topic is for this class.
B) Tell how easy it is to teach the topic to this class.
C) Tell how much you like teaching the topic to this class.

42. Adding, subtracting, and multiplying fractions

	A		B		C
2	not at all important	3	very difficult	0	dislike a lot
13	not important	40	difficult	7	dislike
12	undecided	10	undecided	13	undecided
51	important	40	easy	61	like
23	very important	6	very easy	18	like a lot

43. Adding, subtracting, multiplying and dividing decimals

	A		B		C
0	not at all important	1	very difficult	0	dislike a lot
0	not important	20	difficult	2	dislike
2	undecided	14	undecided	12	undecided
35	important	58	easy	66	like
63	very important	7	very easy	21	like a lot

44. Learning about estimation

	A		B		C
0	not at all important	3	very difficult	1	dislike a lot
3	not important	33	difficult	9	dislike
8	undecided	21	undecided	23	undecided
44	important	37	easy	56	like
45	very important	5	very easy	12	like a lot

45. Working with percent

	A		B		C
0	not at all important	2	very difficult	0	dislike a lot
0	not important	26	difficult	1	dislike
4	undecided	19	undecided	12	undecided
50	important	47	easy	61	like
46	very important	7	very easy	25	like a lot

42. Memorizing basic facts

	A		B		C
0	not at all important	2	very difficult	3	dislike a lot
6	not important	27	difficult	24	dislike
4	undecided	14	undecided	25	undecided
45	important	50	easy	42	like
44	very important	7	very easy	6	like a lot

43. Solving equations

	A		B		C
0	not at all important	2	very difficult	0	dislike a lot
1	not important	34	difficult	2	dislike
3	undecided	15	undecided	11	undecided
54	important	43	easy	62	like
42	very important	6	very easy	25	like a lot

44 Working with perimeter, area, and volume

	A		B		C
0	not at all important	2	very difficult	0	dislike a lot
2	not important	28	difficult	3	dislike
7	undecided	14	undecided	11	undecided
65	important	49	easy	63	like
27	very important	7	very easy	22	like a lot

45. Learning geometry

	A		B		C
0	not at all important	2	very difficult	0	dislike a lot
4	not important	25	difficult	5	dislike
14	undecided	19	undecided	13	undecided
61	important	47	easy	53	like
21	very important	8	very easy	29	like a lot

42. Working with data and graphs

	A		B		C
0	not at all important	0	very difficult	0	dislike a lot
1	not important	14	difficult	2	dislike
6	undecided	15	undecided	10	undecided
64	important	60	easy	60	like
29	very important	11	very easy	27	like a lot

43 Learning how to use calculators

	A		B		C
0	not at all important	0	very difficult	1	dislike a lot
5	not important	4	difficult	4	dislike
6	undecided	13	undecided	15	undecided
49	important	64	easy	59	like
39	very important	18	very easy	22	like a lot

44. Learning strategies for problem solving like looking for patterns and making models

	A		B		C
0	not at all important	10	very difficult	1	dislike a lot
1	not important	51	difficult	8	dislike
3	undecided	15	undecided	21	undecided
37	important	21	easy	52	like
59	very important	3	very easy	20	like a lot

45. Working with integers

	A		B		C
1	not at all important	4	very difficult	0	dislike a lot
5	not important	23	difficult	4	dislike
20	undecided	24	undecided	27	undecided
52	important	40	easy	54	like
22	very important	9	very easy	15	like a lot

GRADE 10 TEACHER QUESTIONNAIRE

Section 1: Background Information

Your responses to the items in this section will help us put together a description of the population of mathematics teachers in the province.

1 What Grade 10 mathematics course(s) are you teaching this year?

54 A) Mathematics 10 only
24 B) Mathematics 10A only
22 C) Mathematics 10 and 10A
1 D) None

2 Sex

80 A) Male
20 B) Female

3. For how many years will you have been teaching mathematics as of June 1990?

13 A) 1-2 years
13 B) 3-5 years
16 C) 6-10 years
12 D) 11-15 years
45 E) More than 15 years

4. What percent of your current teaching load is mathematics?

13 A) 0-20%
16 B) 21-40%
13 C) 41-60%
12 D) 61-80%
45 E) 81-100%

5. To which of the following associations do you belong?
Mark all that apply.

Actual Numbers
112 A) National Council of Teachers of Mathematics
283 B) B.C. Association of Mathematics Teachers
7 C) *Association provinciale des professeurs de l'immersion et du programme-cadre*
140 D) Local Mathematics Specialist Association
108 E) Other professional association(s)
333 F) None of the above

6. How often do you read educational professional journals?

36 A) Frequently (At least one every month)
40 B) Sometimes (Fewer than one every month)
24 C) Rarely

7 How many post-secondary courses in mathematics have you successfully completed? (e.g. For U.B.C. 3 units = 2 courses.)

6 A) 0
19 B) 1 or 2
75 C) 3 or more

8 How many post secondary courses in mathematics methods (pedagogy) have you successfully completed? (e.g. For U.B.C. 3 units = 2 courses.)

25 A) 0
50 B) 1 or 2
26 C) 3 or more

9 What timetable pattern does your school have for Mathematics 10 (or 10A)?

80 A) Ten-month program
17 B) Semester
0 C) Trimester
2 D) Quarter System
1 F) Other

10. What timetable pattern would you prefer for Mathematics 10 (or 10 A)?

22 A) Ten-month program
73 B) Semester
1 C) Trimester
3 D) Quarter System
1 F) Other

Items 11-19 list a number of factors which might be used to explain why some students are not making satisfactory progress in mathematics. Tell how important you believe each factor to be in explaining students' failure to succeed at an appropriate level

11. Lack of ability

54 A) a very important factor
44 B) a factor of minor importance
3 C) a very unimportant factor

12. Misbehavior

34 A) a very important factor
50 B) a factor of minor importance
16 C) a very unimportant factor

13. Indifference or lack of motivation (but not misbehavior)

87 A) a very important factor
11 B) a factor of minor importance
2 C) a very unimportant factor

14 Fear of mathematics

35 A) a very important factor
54 B) a factor of minor importance
12 C) a very unimportant factor

15. Absenteeism

69 A) a very important factor
26 B) a factor of minor importance
6 C) a very unimportant factor

16. Insufficient school time allocated to mathematics

27 A) a very important factor
44 B) a factor of minor importance
30 C) a very unimportant factor

17. Insufficient proficiency on your part in dealing with students having the kinds of difficulties found in the class

12 A) a very important factor
45 B) a factor of minor importance
43 C) a very unimportant factor

18. Limited resources and materials

14 A) a very important factor
48 B) a factor of minor importance
38 C) a very unimportant factor

19 Too many students in the class

43 A) a very important factor
36 B) a factor of minor importance
22 C) a very unimportant factor

20. In your opinion, is there an under representation of girls in any of your Grade 11 or Grade 12 mathematics classes?

6 A) Yes.
45 B) No.
49 C) I don't teach any Grade 11 or 12 mathematics classes.

21. If your answer to the item 20 was Yes, what do think are the reasons for girls being under-represented? Mark all that apply.

Actual Numbers
23 A) Girls don't think that they are good at mathematics.
12 B) Girls don't like mathematics.
19 C) Girls experience peer pressure against taking mathematics.
20 D) Girls don't see any use for mathematics outside of school
11 E) Girls don't think it is feminine to take mathematics
11 F) Girls have been discouraged from taking mathematics by teachers or counsellors

22. Do you think that special efforts should be made to encourage more girls to take senior-level mathematics courses?

59 A) Yes
41 B) No

23. If your answer to the item 22 was Yes, what do you think should be done? Mark all that apply.

Actual Numbers
96 A) Change the curriculum so it would appeal to girls more.
72 B) Change the teaching methods used by teachers.
363 C) Change girls' attitudes toward mathematics.
84 D) Change the expectations of the school.
355 E) Change society's expectations of girls.

24. If your answer to the item 22 was No, explain why. Mark all that apply.

Actual Numbers
256 A) There is no problem of under-representation of girls.
29 B) Schools cannot do anything about the problem.
75 C) Special efforts should not be made for any particular group.

Section 2: Implementation Information

Your responses to the following items will enable us to generate a composite picture of the curriculum as it has been implemented, identify the extent of implementation support available for teachers, and determine the opinions generally held about the new curriculum.

25. As of June 1990, this school will have been using the new provincial mathematics curriculum for

14 A) 1 year.
66 B) 2 years.
19 C) 3 years (or more).
1 D) This school does not use the new curriculum.

26. In the past three years, has your approach to teaching mathematics changed?

69 A) Yes
31 B) No

27. The following is a list of teaching strategies which may reflect changes in your approach to teaching mathematics. Mark all that apply.

Actual Numbers
602 A) I am more likely to use cooperative learning groups.
378 B) I am more likely to encourage individuals to progress at their own rate
359 C) I am more likely to have students use concrete materials.
658 D) I am more likely to encourage students to use calculators.
238 E) I am more likely to have students use computers.
549 F) I am more likely to focus on problem solving processes.
254 G) I am more likely to use an activities approach to teaching mathematics
33 H) Other. Please specify. ______________

28. In the past three years has your approach to student evaluation in mathematics changed?

67 A) Yes
33 B) No

29. The following is a list of evaluation strategies which may reflect changes in your approach to student evaluation in mathematics. Mark all that apply.

Actual Numbers
118 A) I am more likely to have students involved in self assessment
254 B) I am more likely to assess students through informal observations during class time.
561 C) I am more likely to give frequent quizzes and tests.
60 D) I am less likely to give frequent quizzes and tests.
672 E) I am more likely to evaluate problem-solving strategies as well as answers
34 F) Other. Please specify. ______________

30. In terms of assisting me in planning my mathematics instruction, the new Mathematics Curriculum Guide is

14 A) extremely helpful
38 B) very helpful.
39 C) somewhat helpful
6 D) not very helpful.
3 E) of no help at all.

31. The mathematics materials needed to support the new mathematics curriculum (including calculators) have been easy to obtain

6 A) Strongly agree
38 B) Agree
28 C) Undecided
21 D) Disagree
7 E) Strongly disagree

32. I am aware of the availability of in-service programs to support the implementation of the new curriculum (including Ministry-sponsored, District-sponsored, school-based, and others) in the following areas of the new curriculum. Mark all that apply.

Actual Numbers
676 A) Problem solving
452 B) Data analysis
457 C) Geometry
166 D) Measurement
297 E) Algebra
63 F) Other
223 G) None

33. Over the last three years, I have attended

22 A) no in-service sessions in mathematics.
39 B) 1-2 in-service sessions in mathematics.
39 C) 3 or more in-service sessions in mathematics.

34. The in-service support for the implementation of the new curriculum was effective.

10 A) Strongly agree
38 B) Agree
37 C) Undecided
10 D) Disagree
5 E) Strongly disagree

35. The new curriculum helps students learn effective problem-solving strategies

4 A) Strongly agree
36 B) Agree
49 C) Undecided
11 D) Disagree
2 E) Strongly disagree

36. The teaching strategies suggested for the new curriculum are effective e.g. use of manipulatives, use of calculators.

7 A) Strongly agree
54 B) Agree
34 C) Undecided
5 D) Disagree
1 E) Strongly disagree

37. The new curriculum meets the needs of a broad range of student abilities

6 A) Strongly agree
47 B) Agree
28 C) Undecided
16 D) Disagree
3 E) Strongly disagree

38. Students find the new program interesting.

1 A) Strongly agree
29 B) Agree
52 C) Undecided
17 D) Disagree
1 E) Strongly disagree

39. Students see how the mathematics they are learning is relevant to their everyday lives

1 A) Strongly agree
21 B) Agree
34 C) Undecided
39 D) Disagree
5 E) Strongly disagree

40. There is a logical progression of concepts for students to learn as they progress through the grades.

13 A) Strongly agree
68 B) Agree
14 C) Undecided
5 D) Disagree
0 E) Strongly disagree

41. The amount of material to be covered at each grade level is appropriate

3 A) Strongly agree
35 B) Agree
19 C) Undecided
31 D) Disagree
11 E) Strongly disagree

Section 3: Classroom Practices

> Your responses to the items in this section will enable us to describe the kinds of classroom practices associated with the teaching of the new curriculum. Students will be asked the same questions, and the data from both sources will enable us to discuss teaching practices as they relate to achievement at the provincial level.

42. The first Grade 10 level mathematics course I teach (or ta... ...ast semester) in my timetable is (was)

34 A) Mathematics 10A
66 B) Mathematics 10.

For the rest of the items on the questionnaire, please respond with respect to the mathematics class you just identified in item 42 i.e. the specific Mathematics 10 or Mathematics 10A class

43. What is the length of each class period in mathematics?

Math 10	Math 10 A		
0	0	A)	30 minutes
3	3	B)	31-45 minutes
86	89	C)	46-60 minutes
10	7	D)	61-75 minutes
1	0	E)	more than 75 minutes

44. How many periods of mathematics instruction does this class receive each week?

Math 10	Math 10 A		
62	70	A)	3
13	8	B)	4
16	10	C)	5
8	9	D)	6
1	2	E)	more than 6

45. What is the total number of instructional hours assigned to the course?

Math 10	Math 10 A		
3	4	A)	90 hours or less
20	19	B)	91-100 hours
41	38	C)	101-110 hours
29	35	D)	111-120 hours
7	5	E)	More than 120 hours

46. The mathematics text which I use most often for this course is

Math 10	Math 10 A		
2	88	A)	*Math Matters Book 2* (revised) (Nelson).
88	9	B)	*Mathematics 10*, (Addison-Wesley).
8	2	C)	*Principles and Process 10*, (Nelson).
0	0	D)	*Mathematics for a Modern World Book 1* (2/e) (Gage).
0	0	E)	*Modern Algebra Book 1: Module 4* (Houghton-Mifflin)
0	0	F)	*Modern Algebra Book 1: Module 5* (Houghton-Mifflin).
0	0	G)	*Modern Algebra Book 1: Module 6* (Houghton-Mifflin)
0	0	H)	*Mathematical Pursuits One* (Gage).
0	0	I)	*Mathematical Pursuits Two* (Gage).
0	0	J)	*Trouble-Shooting Mathematics Skills* (Gage).
0	0	K)	*Business and Consumer Mathematics* (Addison-Wesley)
0	0	L)	*Career Mathematics, Industry and the Trades*
0			(Houghton-Mifflin).
2	3	M)	Other. Please specify ______________________

47. There is a good match between the text and the curriculum.

Math 10	Math 10 A		
14	17	A)	Strongly agree
73	64	B)	Agree
6	13	C)	Undecided
5	6	D)	Disagree
1	0	E)	Strongly disagree

48. The text is written at an appropriate level of difficulty for the students I teach.

Math 10	Math 10 A		
12	9	A)	Strongly agree
66	38	B)	Agree
10	13	C)	Undecided
11	37	D)	Disagree
2	4	E)	Strongly disagree

For items 49 - 53, think of your mathematics classes during a typical school week

49. I lecture and students take notes from the blackboard or the overhead projector

42 A) Almost every day
29 B) Often
19 C) Sometimes
7 D) Rarely
2 E) Never

50. Students use calculators.

71 A) Almost every day
22 B) Often
6 C) Sometimes
1 D) Rarely
0 E) Never

51. Students work individually on problems from textbooks or other exercises as assigned.

66 A) Almost every day
23 B) Often
9 C) Sometimes
2 D) Rarely
0 E) Never

52. I help individual students

86 A) Almost every day
11 B) Often
2 C) Sometimes
0 D) Rarely
1 E) Never

53. We review homework assignments and discuss solutions.

69 A) Almost every day
21 B) Often
7 C) Sometimes
2 D) Rarely
1 E) Never

49. Students use computers.

7 A) Almost every day
6 B) Often
10 C) Sometimes
20 D) Rarely
57 E) Never

50. Students answer quizzes or tests.

7 A) Almost every day
63 B) Often
29 C) Sometimes
1 D) Rarely
0 E) Never

51. Students work in small groups.

21 A) Almost every day
22 B) Often
31 C) Sometimes
20 D) Rarely
6 E) Never

52. Students use concrete materials (dice, coin, laboratory minipulatives etc.) to assist understanding.

1 A) Almost every day
3 B) Often
30 C) Sometimes
49 D) Rarely
17 E) Never

Section 4: Mathematics in School

Teacher and student perceptions about the importance and difficulty of mathematics topics have a great bearing on student achievement. In order to contribute to our understanding of these relationships, please answer the following questions.

For each of the next items in this scale, three answers are needed.

A) Tell how important you think the topic is for this class.
B) Tell how easy it is to teach the topic to this class.
C) Tell how much you like teaching the topic to this class.

54. Data Analysis

A		B		C	
1	not at all important	1	very difficult	1	dislike a lot
6	not important	21	difficult	12	dislike
25	undecided	28	undecided	31	undecided
55	important	45	easy	43	like
13	very important	5	very easy	13	like a lot

55. Geometry

A		B		C	
0	not at all important	2	very difficult	0	dislike a lot
3	not important	34	difficult	5	dislike
9	undecided	17	undecided	13	undecided
65	important	42	easy	54	like
23	very important	5	very easy	28	like a lot

56. Trigonometry

A		B		C	
4	not at all important	8	very difficult	2	dislike a lot
11	not important	17	difficult	5	dislike
12	undecided	15	undecided	14	undecided
49	important	48	easy	44	like
23	very important	12	very easy	35	like a lot

57. Finding area, perimeter, and volume

A		B		C	
0	not at all important	1	very difficult	1	dislike a lot
8	not important	12	difficult	10	dislike
9	undecided	15	undecided	22	undecided
58	important	59	easy	55	like
25	very important	13	very easy	13	like a lot

54. Solving equations and simplifying expressions

	A		B		C
1	not at all important	4	very difficult	0	dislike a lot
4	not important	31	difficult	4	dislike
3	undecided	10	undecided	8	undecided
34	important	47	easy	48	like
58	very important	9	very easy	40	like a lot

55. Working with exponents

	A		B		C
2	not at all important	2	very difficult	0	dislike a lot
5	not important	27	difficult	4	dislike
9	undecided	11	undecided	15	undecided
57	important	51	easy	58	like
28	very important	9	very easy	23	like a lot

56. Working with decimals, fractions, and percents

	A		B		C
0	not at all important	3	very difficult	1	dislike a lot
5	not important	25	difficult	17	dislike
6	undecided	17	undecided	24	undecided
42	important	46	easy	46	like
48	very important	10	very easy	12	like a lot

57. Estimating answers

	A		B		C
1	not at all important	4	very difficult	2	dislike a lot
3	not important	29	difficult	14	dislike
12	undecided	23	undecided	36	undecided
53	important	39	easy	42	like
31	very important	5	very easy	6	like a lot

58. Problem solving

	A		B		C
0	not at all important	23	very difficult	2	dislike a lot
9	not important	52	difficult	9	dislike
2	undecided	10	undecided	14	undecided
34	important	16	easy	48	like
54	very important	2	very easy	27	like a lot

Vern A. Burkhardt
Queen's Printer for British Columbia
Victoria, 1992